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# MEASUREMENTS OF SOME ABILITIES IN SCIENTIFIC THINKING

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NEED.—Civilized society needs more scientific ability.

There is a most vexing scientific problem which arises daily in all our lives. Some circumstances there are amid which it is wise to rely upon competent authority; others, upon personal investigation; and yet others, upon both. How may our population distinguish among these? Amid what circumstances trust conclusions? Even slightly keener insight into this problem is valuable.

A distinction, vital, yet forming no defined part of these measurements has here to be made,—a distinction, in the sense to be defined, between primary and secondary data. Primary data are selected by the individual from immediate experience; secondary data, from representations of the immediate experience of other individuals. When I see James board the street-car, I am selecting a primary datum. When John tells me that James boarded the street-car, I am selecting a secondary datum. The primary are always the basis. To them is the final reference. They are more educative than the secondary. Their use in our schools is still too rare. Nothing so characterises the modern period of history as its insistence upon building its thought world when it can out of primary data, and its knowledge that secondary data are subjected consciously and unconsciously to certain streams of influence, such as prejudice and carelessness, not to mention greed, from which the sole escape is vigilant comparison with primary data. We in the school are still too exclusively mediaeval schoolmen, in the sense of depending too much upon secondary data for our conclusions, and of being too content to encourage our students to conclude upon the bases of secondary data alone. Too often we accept statements from books instead of those from life that could be found easily and used

convincingly. To let print pass as evidence when experience is both available and educative is to revert to attitudes which it was a function of the Renaissance to replace. For the middle ages Aristotle was a final authority; for this modern age no authority is final. In this age we must train children to rely much upon the testimony of their own senses, taken with their interpretation of the material furnished them by their senses. It is not scientific to rely habitually upon the conclusions of others without seeking primary data, for which the search is often feasible. This emphasis has been placed by some writers and teachers, but it is general neither in thought nor in practice.

When and how to investigate, when and how to recognize authority, when and how to combine investigation with authority,—these are problems of scientific method, of education, and of citizenship. It is sound educational policy to give them central importance in school. How many dismal errors of judgment at critical moments in public and private life could thus be averted,—errors in the choice of political candidates, of employment, of studies, of vocation and avocation, of national and individual friends and enemies, of dress, of residence, of attitudes, of schools, of courses of study, of food, clothing, shelter, education, and amusement,—of all,—everything,—that ever makes or mars our lives?

AIM.—The ultimate aim of this investigation is to aid in focusing attention sharply upon scientific method as the proper method of children's study, both in the eleven abilities tested, and in all other abilities which are at once important and feasible.

The immediate aim of this investigation is to increase the consciousness and effectiveness of the use of eleven scientific abilities.

Scientific ability is used daily both by adults and by children. It is used more or less consciously, accurately, effectively, and appropriately. When pupils make good use of method, their world of data and their education are ordered and relatively useful. The scientific method is the best method. In its highest reaches it is complexity itself. In its simplest forms its elements are employed unconsciously by children in the pre-school age. The published mathematical calculations of the position of the planet Neptune, before it had ever been seen, filled several volumes. A girl of three said: "Big engine says, 'Ding dong;' 'Pussy's in the Well' says, 'Ding dong;' many things say, 'Ding dong.' " She collected two facts and made an inductive conclusion. A child of five, who said,

"A pond is a little round place to sail boats in—with water in," defined imperfectly; nevertheless, to a certain extent, she employed ability number three. Her mental work falls within the concept of scientific method. It is such crudely elementary uses of method by the masses of children upon which we must erect the superstructure of more advanced and finished work. We must teach no less of the content of geography, but we must lay more stress upon teaching children to study, to handle problems, to work methodically, to plan independently their own ways of solving problems, to lay out their own work, to observe precisely, to remember exactly and fully, to think well, to expound clearly,—in short, to use the scientific method.

The ultimate aim of this investigation is wider than the present scope of the test.

DEFINITION.—The competent have never formulated even a tentative concensus of judgment in answer to the question: What is scientific method? In the absence of such an agreement concerning the living and developing complex of processes known as scientific method the following is a more vague and arbitrary statement, of which the first part expresses a general meaning, and the second a meaning narrowed by analysis and selecton to the particular purposes of this investigation.

The aim of science is to explain the world. The aim of *a* science is to explain a limited portion of the world. The scientific method is that complex of processes used in the attempts to explain. It is a complex of processes which are never mutually exclusive. It is a complex into which its elements enter in ever varying frequency, order, and degree. While it can be analyzed usefully, it can be analyzed neither finally,—for scientists alter its use from age to age; nor universally,—for scientists alter its use from field to field.

The history of the theory of scientific method is suggested by such names as Francis Bacon, John Stuart Mill, W. Stanley Jevons, and Karl Pearson.

ANALYSIS.—From among the processes of which the total complex is scientific method, eleven, which have importance with reference to scientific work, and feasibility with reference to inclusion in this scientific method test, have been selected. While all of them together are very far from constituting the whole of scientific method, severally they fall quite within that concept. They are called more or less into play whenever a problem is to be solved carefully,—that

is, whenever the scientific method is to be used. Each ability is a process used in science. In the list following, each is designated by a catch-word. Each catch-word appears at the top of each of three exercises. Each exercise is intended as a partial measure of one ability. (The catch-words do not appear in the test as given to the students.) Following this list is an equal number of paragraphs, each devoted to the definition of one ability.

| | | |
|---|---|---|
| 1. *Value* | 5. *Statistics* | 9. *Classification* |
| 2. *Feasibility* | 6. *Relevancy* | 10. *Arrangement* |
| 3. *Definition* | 7. *Recording* | 11. *Sufficiency* |
| 4. *Clarity* | 8. *Comparison* | |

1. *Value.* The ability of pupils to judge as to the relative values of different problems. Whenever a problem is suggested for solution, this question should arise first: Is the problem worth solving? Will its solution be of enough value to pay for the work it will take? Will the conclusions of the investigation be of worth?

2. *Feasibility.* The ability of pupils to judge whether problems can or cannot be solved. When one has decided that it would be valuable to solve a certain problem, the very next question is: Can it be solved? Can suitable methods be devised? Can enough relevant data be found?

3. *Definition.* The ability of pupils to distinguish good definitions from bad. When one has decided to try to solve some problem, the need of defining some of its terms often arises. Pupils need to know the differences between good and bad definitions. A definition of a thing usually states a class in which the thing belongs, and a mark or marks by which the thing may be distinguished from differing things in the class.

4. *Clarity.* The ability to distinguish sentences which contain no ambiguity from those which contain ambiguity; to locate ambiguity; to recognize clarity of expression.

5. *Statistics.* The ability to know when statistics are needed in the proof of a statement or in the solution of a problem.

6. *Relevancy.* The ability to select facts that relate to the problem and to reject those that do not; to stick to the point. When one has chosen his problem and made clear its meaning, one must know how to select data that will aid in its solution, and to reject those that will not.

*7. Recording.* The ability to select the better from among the poorer methods of recording the facts relevant to a problem.

*8. Comparison.* The ability to distinguish good from bad comparisons. Comparison involves the likenesses and the differences of two or more things.

*9. Classification.* The ability to distinguish between a class containing something foreign to it and a class not containing something foreign to it; to recognize the presence of something foreign in a class.

*10. Arrangement.* The ability to arrange the members of a class in useful sequence; to distinguish between good and bad arrangements. When one has placed the relevant objects or data each in its own class in accordance with some purpose, the members of each class should usually be set one after the other in some sequence. The sequence may be dominated by any one of a great variety of ideas, according to the purpose, such as number, size, color, or degrees of importance, of difficulty, or of obviousness.

*11. Sufficiency.* The ability to judge whether the data are sufficient for the purpose. Having the relevant data thus classified and arranged, no conclusion may be drawn until the question of sufficiency has been answered: Are the data of enough combined weight to prove the point? Are they adequate to solve the problem? One method of proof is never considered sufficient for a proposition of much difficulty or importance, but must, when possible, be supplemented, that is, substantiated, checked, verified, by one or more other methods. Only a verified proof is sufficient. Verification is somewhat the same idea as sufficiency.

The test as given to students is printed on an eight page folder in eight point type. On the first page are blanks for name, date, address, grade, class, teacher, scores, and a sample exercise which is explained and solved. There are also the following:

### Directions to Students

These exercises are given to see how well you can think. On the following pages you will find other exercises like the sample above. Do the first, then the second, and then the others in order, until you have done all you can. You will have all the time you need. Work all the time. Look over each exercise, after you have done it, to be sure you have done it right. If you make any mistake, correct it. Ask no questions. Let no one help you.

After you have done all the exercises you can, take them to the teacher at once. Take your pencil with you. As soon as the teacher has written down how long it took you to do the test, write the answers to the two questions below:

Did you get any help on any exercise on the following pages? Answer "Yes," or "No.".....

If you did, what help did you get?.....

## THE TEST

### *1. Classification*

Put a cross on the line before the word that is in the wrong group of words; but if there is no such word, put a cross here.....

| *Animals* | *Buildings* | *Foods* | *Fruits* |
|---|---|---|---|
| .....cat | .....house | .....meat | .....apple |
| .....cow | .....barn | .....bread | .....dog |
| .....horse | .....store | .....butter | .....cherry |

### *2. Clarity*

Put a cross on the line before the sentence that is not clear; but if there is no such sentence, put a cross here.....

.....Some lakes are small, some lakes are large, and some are very large.
.....Some ponds are small, and some are large.
.....Men are not all the same height, for some are taller than others.
.....Some men are short, and some men are very tall.
.....Some women are short, and some women are very tall.
.....Women are not always of the same height as men.
.....Many ponds are small.
.....Many lakes are large.
.....John and James went fishing, and he was drowned.
.....Some mountains are larger than others.
.....Some lakes are larger than others.
.....Some men are taller than others.

### *3. Relevancy*

Put a cross on the line before the fact that helps show that the air is colder high up than it is low down; but if there is no such fact, put a cross here.....

.....Tables have four legs, braces, and tops, and are very useful for many purposes.
.....Chairs have four legs.
.....Some houses are colder than others.
.....Cradles sometimes rock.
.....Some men are colder-blooded than others.
.....The animals give us much food and clothing.
.....Horses are larger than dogs.
.....Mountain peaks are cold.
.....Animals usually have ears.
.....Animals usually have eyes.
.....Some animals are colder-blooded than we.
.....Some chairs rock.

*4. Definition*

Put a cross on the line before the best way of telling what a pond is; but if there is no such way, put a cross here.....

.....A thing with water all the way around it.
.....Something useful to boys and girls who like to swim.
.....Something surrounded by people who are talking.
.....A small body of water surrounded by land.
.....A house surrounded by a large forest in this country.
.....A street.
.....A number.
.....A book.
.....Lands.
.....Water and land.
.....A body of water, large or small, and almost surrounded by land.
.....A body of land.

*5. Feasibility*

Put a cross on the line before the statement that would be too hard to prove true; but if there is no such statement, put a cross here.....

.....Some children are taller than others.
.....Some women are older than others.
.....Some old men are smaller than others.
.....Some children are larger than others.
.....Some children have better homes than others.
.....Some children know more than others.
.....Some children know less than others.
.....The brightest child lives in Boston.
.....Children go to school, at least in this part of the world.
.....Grown people do not.
.....Some men know more than others, and the same is true of women.
.....Some men know more than some women.

*6. Arrangement*

Put a cross on the line before the group of things that come in the best order; but if there is no such group, put a cross here.....

.....baby, boy, young man, old man
.....baby, young man, old man, boy
.....old man, boy, baby, young man
.....baby, boy, old man, young man
.....old man, young man, baby, boy
.....boy, old man, young man, baby
.....boy, baby, young man, old man
.....young man, old man, boy, baby
.....young man, baby, boy, old man
.....boy, old man, young man, baby
.....baby, boy, old man, young man
.....old man, young man, baby, boy

*7. Clarity*

Put a line under the word that makes the following sentence not clear; but if there is no such word, put a cross here.....

Boston and New York are both large cities, but it is smaller than the other.

*8. Recording*

Put a cross on the line before the best way of keeping facts in geography until you are ready to use them; but if there is no such way, put a cross here.....

.....Write them down, put the paper in your book, and lose the book.
.....Talk plainly to someone who knows how to keep the facts he will want to use.
.....Write your name.
.....Write a friend's name, then your mother's, and then your father's.
.....Speak.
.....Speak loud.
.....Go somewhere.
.....Write the facts down, using just a few words for each.
.....Write.
.....Write your name fast; then write it again and again without stopping.
.....Write your name slowly.
.....Write your name well; then try to write it better and better.

*9. Sufficiency*

Put a cross on the line before the way by which you could surely find out how much rain falls in New York City in a year; but if there is no such way, put a cross here.....

.....Ask any one you meet.
.....Think about it hard.
.....Look in the right book.
.....Ask some friend who lives far away.
.....Ask two friends who live near.
.....Guess at it.
.....Guess at it and have two or three friends guess at it.
.....Sit still.
.....Do not whisper; always do what your teacher tells you to do.
.....Be good.
.....Sit still and think hard.
.....Write about it to your friends.

*10. Arrangement*

Put a cross on the line before the best order of things; but if there is no such order, put a cross here.....

.....cloud rain river brook ocean
.....rain cloud brook river ocean
.....ocean rain cloud brook river
.....river ocean rain cloud brook
.....cloud brook river ocean rain
.....brook river ocean rain cloud
.....brook rain cloud river ocean
.....rain cloud river ocean brook
.....cloud river ocean brook rain
.....cloud rain brook river ocean
.....river ocean brook rain cloud
.....ocean brook rain cloud river

*11. Value*

Put a cross on the line before the question that is most important to the greatest number of persons; but if there is no such question, put a cross here.....

.....Is your father ill?
.....Does Mr. Jones own his house?
.....Is your pencil sharp?
.....Can you run a mile without stopping?
.....Will the earth continue to have enough light?
.....Does a pound of feathers weigh as much as a pound of lead?
.....Does candy ever cost eighty-five cents a pound?
.....Does candy ever cost thirty-five cents a pound?
.....Are some fire-places built of brick?
.....Are some of the very best stoves made of iron?
.....Have tables four legs each?
.....Do some chairs rock?

*12. Definition*

Put a cross on the line before the best way of telling what a pond is; but if there is no such way, put a cross here.....

.....A body of water wholly surrounded by land.
.....A body of water surrounded by land.
.....Water which is of use to boys and girls.
.....Water surrounded by land.
.....A small body surrounded by land.
.....Still water.
.....A small body of water surrounded by land.
.....A body of land surrounded by water.
.....A large body of water surrounded by land.
.....A small body of land surrounded by water.
.....A body of land fitted for man to live on.
.....Land and water.

*13. Feasibility*

Put a cross on the line before the statement that can be proved true; but if there is no such statement, put a cross here.....

.....The telephone is just as useful as the telegraph.
.....The heat of summer is harder to bear than the cold of winter.
.....It is better for all persons to live in valleys than upon hills.
.....Next summer will be hotter than last summer.
.....There is always too little rain.
.....Dogs never do harm.
.....Iron-making is the most useful industry.
.....Canada is farther north than the United States.
.....Sometimes two persons are just alike.
.....Sometimes two blades of grass are just alike.
.....A pound of lead weighs more than a pound of feathers.
.....Sometimes two Americans are just alike.

*14. Relevancy*

Put a cross on the line near the statement that helps show that air is colder high up than it is low down; but if there is no such statement, put a cross here.....

.....Too little rain hurts plants.
.....Men can sail in the Arctic Ocean only a small part of the year.
.....There is snow in summer on some mountains.
.....Plants grow fast in warm, wet places.
.....Dogs have saved many persons lost in the snow.
.....The North Pole was discovered.
.....It is cooler in the shade than in the sun.
.....Snow lasts longer in the shade than in the sun.
.....There are railroads on the sides of some high mountains.
.....Men should be strong to climb some high mountains.
.....Too great cold hurts plants.
.....Frost hurts some plants.

*15. Comparison*

Put a cross on the line before the sentence that shows a difference between two things; but if there is no such sentence, put a cross here.....

.....The Mississippi River is long, winding, and beautiful.
.....Some rivers are short, rapid, and almost useless.
.....The Mississippi River carries boats of many kinds.
.....The boats carry cotton, wheat, and other things, besides passengers.
.....China makes 15 million pounds of silk a year, Japan 7.
.....Many boats carry passengers up and down the Mississippi River.
.....Many of the boats have water-wheels to make them move.
.....The water-wheels are placed at the ends of the boats.
.....The water-wheels turn because they are driven by the engines.
.....The turning makes the boats go.
.....The boats have engines.
.....The engines make the wheels turn.

*16. Statistics*

Put a cross on the line before the statement that could be more surely proved by using numbers than in any other way; but if there is no such statement, put a cross here.....

.....Some boys use boats well; some build boats well, too.
.....Both girls and boys go to school in this country.
.....Men and women in this country sometimes work to earn a living.
.....Schools are made for teaching; they are sometimes used for public meetings.
.....Children go to school to study.
.....Children go to school to learn to study; they do not always succeed.
.....There are teachers who do not teach children to study.
.....There are beautiful children who go to school.
.....This country contains some wildcats.
.....A pound of sugar costs more than a pound of flour.
.....Some houses are built of brick.
.....A most important thing about school is learning to study.

*17. Classification*

Put a cross on the line before the best grouping of things; but if there is no such grouping, put a cross here.....

.....house lion wildcat cat tiger school-house store
.....house store cat lion tiger store wildcat
.....lion cat store house tiger store wildcat
.....tiger store wildcat lion cat store house
.....tiger store wildcat house store cat lion
.....tiger lion wildcat cat house school-house tiger
.....house wildcat store tiger store wildcat
.....house store wildcat tiger wildcat store
.....lion house cat store tiger wildcat store
.....house school-house store tiger lion wildcat cat
.....tiger wildcat store lion store house cat
.....house store cat lion tiger wildcat store

*18. Value*

Put a cross on the line before the question that is most important to the greatest number of people; but if there is no such question, put a cross here.....

.....Will the sun continue to rise every morning?
.....Are evergreens found in many parts of the earth?
.....Is coal found in Alaska?
.....Do rivers always flow from higher to lower ground?
.....Do some mountain ranges run from north to south?
.....Do some mountain ranges run from east to west.
.....Was tobacco discovered in this country?
.....Has the telephone been used for many years?
.....Is coal mined in this country?
.....Does water freeze in very cold weather?
.....Does the moon go around the earth in about twenty-eight days?
.....Is oil found in the earth with coal in this country?

*19. Value*

Put a cross on the line before the question that is most important to the greatest number of people; but if there is no such question, put a cross here.....

.....Does man raise enough wheat?
.....Do the forests yield enough wood?
.....Do the strongest nations have the best schools?
.....Do our cows and goats yield enough milk?
.....How much coal is there left in the earth?
.....Are the fur-bearing animals in danger of being killed in too great numbers?
.....Are inland countries well connected with the sea by means of rivers?
.....Are the continents well connected with each other by means of the oceans?
.....Will the earth continue to have a good supply of heat?
.....How much is the telephone used in the country?
.....In what languages are the best books likely to be printed?
.....How many more automobiles have been sold during the last year than during the year before that?

*20. Statistics*

Put a cross on the line before the statement that could be more surely proved by using numbers than in any other way; but if there is no such statement, put a cross here.....

.....Manufacturing is of great financial importance in Germany.
.....Chairs are made of wood, nails, screws, glue, cloth, tacks, and paint.
.....Swings are made of wood, nails, screws, chains, and other things.
.....Mining is an interesting work.
.....Iron and steel are in some ways alike and in some ways different.
.....Mountains are beautiful.
.....Lakes and mountains make beautiful scenery when seen together.
.....Islands, lakes, and mountains make beautiful scenery.
.....The United States, Canada, and Mexico contain beautiful scenery.
.....To the people of the United States the camel is a strange animal.
.....The Chinese have customs that are strange to us.
.....The Indians have strange customs.

*21. Definition*

Put a cross on the line before the sentence that tells best what a river is; but if there is no such sentence, put a cross here.....

.....A river is a body of water; the body of water is in motion; the body of water is sometimes blown upon by the wind.
.....A river is flowing water.
.....A river is a large stream of water flowing through the land toward some other stream or body of water.
.....A river is a stream of water flowing rapidly through the land, and finally reaching the ocean.
.....A river is a stream of water flowing in a channel on land toward some other stream or body of water.
.....A river is water.

.....A river is a large stream of water flowing through a channel toward some other stream or body of water.
.....A river is a stream flowing in such a way as to be of use to man.
.....A river is a current of water.
.....A river is a large current of water.
.....A river is a current of water flowing through the land.
.....A river is a stream of water flowing through the land; it is used for carrying boats.

*22. Recording*

Put a cross on the line before the best way of keeping facts in geography until you use them; but if there is no such way, put a cross here .....

.....Remember them even when it is hard to do so.
.....Copy them from books.
.....Copy sentences from books.
.....Keep a note-book.
.....Keep several note-books.
.....Think hard and carefully as you work.
.....Think hard and carefully as you find the facts.
.....Let your teacher do it for you.
.....Remember everything you read.
.....Write each fact briefly and correctly.
.....Try to remember the best of what you read.
.....Always try to remember the best of what you read.

*23. Sufficiency*

Put a cross on the line before the way by which you could surely find out how much rain falls in New York City in any one night; but if there is no such way, put a cross here.....

.....Ask your best friend.
.....Ask your teacher at some time when she has not too much to do, so that she will have time to answer you carefully and fully.
.....Ask your mother at night when you have reached home after school, at some time when she is not too busy, and when she is not too tired.
.....Ask your father.
.....Walk one mile alone, so that you may think about it without anyone to talk to you.
.....Ask a friend.
.....Walk two miles alone, dressed for the weather, so as to be free to think hard about the rain.
.....Eat dinner at six, after a long walk in the open air with your best friends.
.....Guess at it.
.....Ask your father at night, after he has come from work and has finished his dinner.
.....Catch rain all night in the right cup rightly placed.
.....Sit in a chair, quietly thinking all the time about the weather and the rain

*24. Feasibility*

Put a cross on the line before the statement that could be proved true; but if there is no such statement, put a cross here.....

.....The United States will always be the richest nation in the world.
.....The United States will not always be the richest nation in the world.
.....The theatre helps educate the world.
.....The theatre does not help educate the world.
.....China will some day rule the world.
.....China will never rule the world.
.....All great men are Europeans.
.....No great men are Europeans.
.....Europe will always be the richest continent.
.....Europe will never be the richest continent.
.....Asia will sometime give the world the richest men.
.....Asia will never give the world the greatest men.

*25. Recording*

Put a cross on the line before the best way of keeping facts of geography until you are ready to use them; but if there is no such way, put a cross here.....

.....Remember them by using your own best way of remembering facts.
.....Copy them fully from books. Copy the whole of each sentence. Save these copies until you need them.
.....Remember where they are so that you may be able to find them again easily whenever you want them.
.....Copy sentences from books, leaving out words like "the" and "a," and any other words that have little meaning.
.....Keep a note-book in which you write down everything you wish to keep, whether it was found in reading or in observing.
.....Keep a note-book. Write each fact.
.....Keep each fact you need by writing it in few and chosen words in a note-book.
.....Keep a note-book. Use a sentence for each fact.
.....Find the true connections among the facts; memorize these, and talk from memory.
.....Memorize everything you read.
.....Try to remember the important facts you read.
.....Always try to memorize the more important facts you read.

*26. Clarity*

Put a cross before the sentence that is not clear; but if there is no such sentence, put a cross here.....

.....Some rivers flow into rivers, and some flow into the ocean.
.....Many rivers flow into the ocean, but not all flow into the ocean.
.....Many brooks flow into lakes, and many brooks flow into rivers.
.....Does water always flow down hill?
.....Does water ever flow up hill?

.....Two plowmen were talking to two other plowmen about their land.
.....Flames usually go up, not down or to the side.
.....The sun gives us light and heat every day.
.....The earth turns around in exactly 24 hours.
.....Some years are longer than others, and the longer years are called leap-years.
.....Cows give milk, but the milk they give is not all alike; some milk is better than other milk.
.....Men milk cows.

*27. Arrangement*

Put a cross on the line before the best arrangement of things; but if there is no such arrangement, put a cross here.....

.....valley hill mountain; ice steam water; drop brook river
.....steam ice water; drop brook river; hill valley mountain
.....hill mountain valley; steam ice water; drop brook river
.....mountain hill valley; drop brook river; steam ice water
.....hill valley mountain; steam ice water; drop brook river
.....mountain valley hill; drop brook river; steam ice water
.....ice steam water; drop brook river; hill mountain valley
.....water steam ice; valley hill mountain; drop brook river
.....steam water ice; brook drop river; valley hill mountain
.....brook drop river; steam water ice; valley hill mountain
.....brook river drop; ice water steam; hill mountain valley
.....valley hill mountain; ice water steam; drop brook river
.....brook river drop; ice water steam; hill mountain valley

*28. Comparison*

Put a cross on the line before the sentence that best shows a difference between the Pacific Ocean and the Atlantic Ocean; but if there is no such sentence, put a cross here.....

.....One ocean is larger than the other.
.....The Atlantic Ocean is smaller than the Pacific Ocean.
.....The Pacific is much larger than the Atlantic.
.....Both oceans have currents of water flowing through them.
.....Both oceans are large bodies of water.
.....The Pacific has more square miles than the Atlantic.
.....The Pacific contains many thousands of square miles.
.....The Atlantic contains many thousands of square miles.
.....Both bodies of water contain salt.
.....The Atlantic ocean connects us with far-off lands.
.....The Pacific connects us with far-off lands.
.....Both oceans are useful, both are large, both carry ships, both have storms, and both are beautiful.

*29. Comparison*

Put a cross on the line before the best comparison; but if there is no such comparison, put a cross here.....

.....Lake Huron is larger than Lake Michigan
.....Lake Michigan is deeper than Lake Huron.
.....Both lakes are very large.
.....Lake Michigan and Lake Huron are two lakes in the same water system; they are of nearly the same size; both carry much traffic; both carry many of the same boats. But the former has 22,322 square miles of area and 750 feet of depth, while the latter has only 21,729 square miles of area, but 870 feet of depth.

| | Area | Elevation | Greatest Depth |
|---|---|---|---|
| .....Huron | 22,322 | 582 | 750 |
| Michigan | 21,729 | 582 | 870 |

| | Area in square miles | Elevation in feet | Depth in feet |
|---|---|---|---|
| .....Huron | 22,322 | 582 | 750 |
| Michigan | 21,729 | 582 | 870 |

.....These lakes show both likenesses and differences. The following are likenesses: (1) Both are in the same water-system. (2) Both carry much of the same traffic. (3) They have the same elevation, 582 feet. (4) Their areas are nearly equal, Huron having 593 square miles more than Michigan. (5) The lakes are much alike in shape, Huron being about three times as long as wide, and Michigan about four.
.....These lakes show both likenesses and differences. The following are likenesses: (1) Both are in the same water-system. (2) Both carry much the same same traffic. (3) They have the same elevation above sea-level, 582 feet. The following are differences: (1) Huron has 22,322 square miles of area, and Michigan 21,729. (2) The lakes differ in shape, Huron being about three times as long as wide, Michigan about four. (3) The greatest depth of Huron is 750 feet, Michigan 870.
.....Huron and Michigan are nearly the same size.
.....Huron is shorter than Michigan.
.....Lake Huron does not have Chicago upon its shore.
.....Both lakes are useful.

*30. Classification*

Put a cross on the line before the best grouping of things; but if there is no such grouping, put a cross here.....

| | |
|---|---|
| cat horse crab man fish dog | cat horse crab man fish dog |
| .....tree bush wood man apple | .....tree bush wood apple fruit |
| stone iron lead tin steel | stone iron man lead tin |

cat horse crab man fish dog
.....tree bush wood apple fruit
stone iron lead tin steel

cat horse crab man dog
.....tree bush wood apple fruit
stone iron lead tin man

cat horse crab man fish dog
.....tree bush wood apple fruit
stone iron bush tin steel

cat horse crab man fish dog
.....tree bush wood apple fruit
stone iron lead man steel

cat horse crab man fish dog
.....tree bush man wood apple
stone iron lead tin steel

cat horse crab man fish dog
.....tree bush iron wood fruit
stone iron lead tin steel

cat horse crab man fish dog
.....tree bush tin wood apple
stone iron lead tin steel

cat horse crab man fish dog
.....tree bush stone apple fruit
stone iron lead tin steel

cat horse crab man tin dog
.....tree bush wood apple fruit
stone iron lead tin steel

cat horse crab man fish fruit
.....tree bush wood apple fruit
stone iron lead tin steel

*31. Relevancy*

Put a cross on the line before the fact that helps show that air is colder high up than it is low down; but if there is no such fact, put a cross here.....

.....More snow fell in the spring of 1888 in New England than for many springs before.
.....Northern people moving to the south can live best in the high regions.
.....Men who fly in flying machines must sometimes dress warm.
.....It is colder in a well than at the top of it.
.....It is much colder in the northern part of Alaska than in the southern.
.....High towers have been blown down by the wind in many parts of the world.
.....The Washington Monument is 555 feet high.
.....Trees will not grow at the north pole, nor will they grow at the south pole.
.....Bears sleep through the winter.
.....Many birds that live in the north during the summer fly south for the winter.
.....A mountainous country is more beautiful than a flat one.
.....It often feels colder out of doors than in a room with windows and doors shut.

*32. Statistics*

Put a cross on the line before the statement that would need the most numbers to prove it; but if there is no such statement, put a cross here.....

.....Many plants grow fast in warm, wet places.
.....Many men raise wheat in the uppper Mississippi valley.
.....Wheat is the chief crop of the upper Mississippi valley.

.....Canada raises more wheat and corn than the United States.
.....Large quantities of corn and oats grow in the United States.
.....The United States is a great manufacturing nation.
.....Water covers two-thirds of the earth's surface.
.....More rain falls on the western coast of this country than upon the eastern.
.....China makes 15 million pounds of silk a year, Japan 7 million.
.....It is sometimes cold in Canada.
.....It is sometimes cold in England.
.....It is sometimes cold in the United States.

*33. Sufficiency*

Put a cross on the line before the way in which you could surely find out how much rain falls in any one year in New York; but if there is no such way, put a cross here.....

.....Save the newspaper reports.
.....Ask a good weather-man.
.....Catch rain in a dish every time it rains; measure the amount; save the records.
.....Take the government statement of the average rainfall per year.
.....Watch the rains yourself, carefully guessing the amount each time it rains, and saving the records.
.....Catch rain all the time it rains in a dish carefully made for that purpose.
.....Read rainfall reports from all the important cities of the United States.
.....Take the daily weather report of the newspapers, save the figures, and add up at the end of the year.
.....Read newspapers and reports.
.....Ask a good teacher in geography.
.....Read all the New York papers.
.....Discuss the matter carefully with a group of friends.

## THE RIGHT ANSWERS

Each exercise is either right or wrong. Mark wrong all cases of crosses on more than one line. Mark wrong all cases of really ambiguous placing of a cross. Any mark which clearly indicates an answer here designated as a correct answer, should be marked correct. Some children mark with a slanting or vertical line. This should be counted correct. The right answers are below. No other answers may be counted correct.

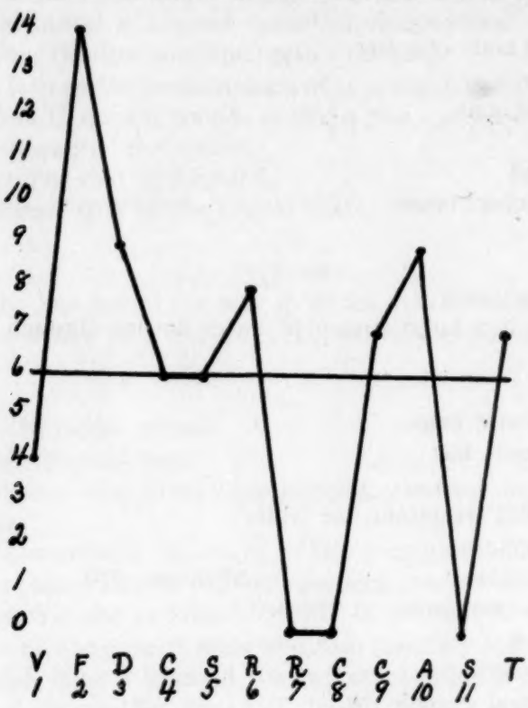
1 x dog
2 x John
3 x Mountain
4 x A small
5 x The
6 x baby, boy, young
7 x it
8 x Write the facts
9 x Look

10 x cloud, rain, brook
11 x Will
12 x A small body of water
13 x Canada
14 x There is snow
15 x China
16 x A pound
17 x house school-house
18 x Will
19 x Will
20 x Manufacturing
21 x A river is a large stream of water flowing through the land
22 x Write
23 x Catch
24 x The theatre helps
25 x Keep each fact
26 x Two
27 x valley hill mountain; ice water
28 x The Pacific is
29 x These lakes . . . . Michigan 870.
30 x (The second group at the left.)
31 x Northern
32 x The United
33 x Ask a good weather man.

MEANS.—The means is found in the analytical diagnosis of classes and of individuals afforded by the test. This is illustrated in the case of one class and of one pupil below:

This illustration suggests that L. S. needs improvement in the abilities here named recording, comparison, and sufficiency. She seems especially good in her judgment of the feasibility of problems, and about average in her other abilities. The individual graph is, of course, less reliable than the grade graph would be. Suppose, however, that the ability of L. S. to tell good from bad comparisons were really near the median of her class instead of far below it, as indicated by her graph. If this fact is discovered, the graph has served its purpose. Taken with the extended observations of a teacher, and perhaps of a principal, the graph will constitute a real value, will offer a tentative analysis of the child's ability, and will suggest means of improvement.

At the outset two courses were open: to study one ability intensively, or to survey in a preliminary way a field made up of several abilities; to investigate, for instance, judgments as to the values of different problems (ability 1), or to look more broadly and less




Graph showing the performance of a sixth grade class and of individual L. S. The vertical scale at the left is of P. E. units of difficulty. The horizontal row of numbers and letters is read thus: Ability 1, value; ability 2, feasibility; etc. (See page 5.) The variations of L. S. above and below her class appear. T means time.

deeply upon judgments involved in the exercise of the eleven abilities. The more inclusive scope was selected, the test in the present form being the result. Through this test conclusions as to the group standing of a class of pupils in each of the eleven abilities may be drawn. This preliminary survey of portions of the great field of scientific ability may properly be followed by a more searching one composed of a series of tests, one or more for each of the eleven abilities and for other abilities. Through such a series conclusions could be drawn regarding the abilities of individual pupils,—conclusions which would possess a degree of reliability not contemplated in the present work.

RELIABILITY.—The reliability of conclusions expressed, upon the basis of the present test, by graphs for classes of pupils, would be sufficient; for individuals, usefully suggestive. Consider, however, the case for the reliability of the individual graph. Exercise number one calls for at least twelve classification judgments before the right answer can be made with confidence. Since there are

thirteen possible places for a cross, the chance for getting an exercise right without thinking is about eight per cent. The probability, therefore, that a cross on the line before the word *dog* is placed there as the result of careful thought is great, while the probability that three crosses on the right lines in the set of exercises labelled *classification* are placed there as the result of careful thought is very great. Students getting all three right really know something about classification. There would be of course a negligible number of exceptions in a large number of cases. It is true that an exception is not negligible for the individual that happens to be concerned, but the frequency would be low with which more than one or two of the ability scores of an individual would be much wrong. This graph is a usefully suggestive conclusion. It is at the same time the most vital and the least reliable conclusion. It will be important to develop at a later time two commensurate series of scaled exercises for each ability, in order to obtain very accurate graphs for each child.

A precise measurement of one trait in one individual by means of the present test is not contemplated, for such a measurement could not be based upon responses to three exercises. Four scores only are possible: none right, one right, two right, and three right.

CLASSIFICATION OF THE TEST.—This is a test of method, not of content. One class of mental measurements concerns the subjects of the curriculum, as spelling, reading, writing, and arithmetic. It deals with the content of subjects. Another class studies capacities and abilities each of which is used in several or in all of the subjects of the curriculum. In this class belong measurements of intelligence, memory, and reasoning. In this class also belongs this scientific method test, which aims to measure the abilities of students to use certain elements of the scientific method. All the content of this test falls within the subject of geography, but the aim is to measure the ability to use scientific method in geography, not the ability to remember geographical content.

Both method and content are of worth. To whatever extent an ability to employ a method may be transferred from field to field by students,—and even if it may not be transferred at all, it is still an essential to progress within the field. Content is the other essential. It is the whole world. Its study broadens the view. It is the material upon which we use method. Yet it means relatively little to our matriculating boys and girls without some conscious mastery of method.

THE HISTORY OF THE TEST.—The test is in its third edition. After an experiment with a brief first edition on October 31, 1916, all the exercises were for one reason or another discarded. It had consisted of nine exercises somewhat similar in form to those of the present edition. A second edition of forty exercises was then prepared. There were three or four exercises to measure each of the eleven abilities. These exercises were submitted to six judges for two purposes: to determine the validity of the answers and the fitness of each exercise as a measure of a specified ability. For instance, numbers 3, 14, and 31 are intended to measure relevancy judgments. Do they do this, or do they do something else? Are the students who score high in these three exercises the ones whose relevancy judgments are usually good? The question is a fair one. Within limitations there is an answer. The six judges were chosen for mental acumen and for their long study of scientific method. One is the head of a department of philosophy, of which two others are members; one is a member of a department of history, and one of a department of mathematics,—all these in a university; and one is an engineer and a teacher of mechanical drawing in a high school. Each spent from two to five hours upon the exercises. They worked separately, and except in one case had not seen the exercises before doing the work. To each were presented the forty exercises and the list of abilities substantially as defined above. Each stated which, if any, of the abilities was tested by each exercise. Not even at first was there a discouraging amount of disagreement. Some exercises were discarded, some modified slightly, and some rebuilt. At last the judges came to a practical agreement. Below is a tabulation of the responses of the judges, (a, b, c, d, e, f,) to the question: Does each exercise test that which it is designed to test? As to the correctness of the answers, each judge passed upon that point for each exercise as a preliminary to the tabulated judgment above. Each exercise needing it was modified until it met the approval of each judge before whom it came. The v's serve therefore as a tabulation of this judgment also. Every exercise has only v's because each one not at first receiving them was modified until it did.

| | a | b | c | d | e | f |
|---|---|---|---|---|---|---|
| 1 | v | v | v | v | v | |
| 2 | v | v | v | v | v | |
| 3 | v | v | v | v | v | |
| 4 | v | v | v | v | | |
| 5 | v | v | v | v | v | |
| 6 | *v* | | *v* | *v* | v | v |
| 7 | v | v | v | v | v | |
| 8 | v | v | v | v | v | |
| 9 | *v* | v | | v | v | v |
| 10 | *v* | *v* | v | v | v | v |
| 11 | *v* | v | *v* | v | v | |
| 12 | v | v | v | v | v | |
| 13 | v | v | v | v | v | |
| 14 | v | v | v | v | v | |
| 15 | v | v | v | v | v | |
| 16 | v | (v) | v | v | v | |
| 17 | v | v | v | v | (v) | v |
| 18 | *v* | v | *v* | v | v | |
| 19 | *v* | v | *v* | v | v | |
| 20 | v | v | v | v | v | |
| 21 | v | v | v | v | | |
| 22 | v | v | v | v | | |
| 23 | *v* | v | v | v | v | v |
| 24 | v | v | v | v | | |
| 25 | v | v | v | v | v | |
| 26 | v | v | v | v | v | |
| 27 | (v) | v | v | v | v | |
| 28 | v | v | v | v | v | |
| 29 | v | v | v | *v* | | v |
| 30 | v | v | v | v | (v) | v |
| 31 | v | v | (v) | v | | |
| 32 | v | v | v | v | | |
| 33 | *v* | *v* | | v | v | v |

v.....Judge gave the opinion that the exercise would test the use of the ability with which it is labelled.

*v*.....Judge gave such an opinion after some modification of the exercise, which was then submitted to the other judges indicated.

(v).....Judge agreed with the label after a brief discussion.

The exercises have also been through the processes of renovation and rebuilding as the result of two trials, one with the first and one with the second edition. It would be too much to state that each set of three exercises measures all that which is defined under its catch-word and nothing more; but it is hoped that each set of three is a significant measure of some considerable portion of that which is defined and of little else.

In March, 1917, the forty exercises of the second edition were submitted to 140 grade school pupils and to 141 high school pupils. So far as could be seen most of the exercises were good ones. Seven were discarded, leaving three for each of the eleven abilities,—thirty-three in all. The text of the test seemed now to have been fitted for a more extended use. About 1800 grade pupils took the test in May, 1917, and others will soon take it in grade schools, high schools, and colleges.

Throughout the building of the test, it has been the aim to reduce toward a minimum the difficulties of the directions found at the beginning of each exercise, of the wording, and of the content of

the test. Yet the trite, but pertinent question: What is measured? is sure to make its appearance. The safe answer is: Responses to the thirty-three exercises of the test, as printed, are measured. The question: Does the test measure abilities as defined? must, in the last analysis, be answered by those who read the statistics and conclusions to be published at some future time.

CONCLUSION.—Our schools now confront a danger arising from an embarrassment of riches. They are to be felicitated on having in their stock-rooms splendid supplies of measuring tests, which are being put to excellent use,—tests in the four fundamental processes and the reasoning of arithmetic, in punctuation, in spelling, in language, in oral and silent reading, in handwriting, and in drawing. But it happens to be generally true that those human abilities which it seemed proper to measure first, perhaps because they could be measured easily, did not happen to be those of the greatest value socially. Such measurements as those of ability in silent and rapid reading, of intelligence, of thinking, and of judgments are of the utmost value. Coupled with the tendency to measure first that which seemed most feasible, there has been, fortunately, some tendency to measure first that which seemed most important,—provided it seemed also feasible. The latter tendency is right. Together with the further development of tests which involve mainly memory, we need a proportionate production of tests of the highest mental qualities,—so far as these may be measured. While the measurement of scientific ability is beset with difficulty, still it is dealing, not mainly with memory, nor addition, nor spelling, nor punctuation,—important as these are,—but with the noblest intellectual function, judgment.

# A STANDARDIZATION OF CERTAIN OPPOSITES TESTS

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The frequency of the use of certain forms of opposites tests in educational measurements, and the unusual reliability of the results make a careful standardization of these tests desirable. Early results, such as those obtained by Simpson,* and by Bonser† are certainly significant; but the lack of uniformity in the type of stimulus, in methods of giving the tests, and in determining the correct response words, have thus far made comparison of results obtained almost impossible.

One of the first attempts‡ at the standardization of tests of this type was made by Professor Irving King and Hugo Gold¶ of the State University of Iowa in 1915–16. "The object of this study was to take certain lists of words which have been used by various experimenters for opposites tests, to give these tests under the best possible conditions, and to attempt to standardize a list or lists from which one might expect reasonably uniform results (when given under like conditions); and furthermore to standardize the grading of opposites tests by determining the words likely to be given as the opposite of each word, their frequency, and their relative values." Four lists of twenty easy stimulus words, and four lists of twenty hard stimulus words as used by Simpson were selected. These lists were given individually to one hundred subjects consisting of nine faculty members, twenty-three graduate students, forty-seven seniors, and twenty-one juniors, all in the departments of education and psychology in the University of Iowa.

On the basis of these responses the following graded list of Simpson's Hard Stimulus words was recommended. The order of the words indicates the difficulty beginning with the easiest:

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*SIMPSON—*Correlation of Mental Abilities;* Teachers College, New York, 1912.

†BONSER—*Reasoning Ability of School Children;* Teachers College.

‡An earlier standardization of a different list was made by Woodworth and Wells.

¶KING AND GOLD—*A Tentative Standardization of Certain Opposites Tests;* Journal of Educational Psychology, Vol. VII, 459–482, 1916

Remember, after, sell, wild, straight, to win, beautiful, increase, rough, succeed, strength, silly, to hold, generous, to bless, over, simple, part, refined, despondent, to take, to spend, to lack, to float, vertical, apart, belief, stingy, active, to degrade, cruel, broken, innocent, to reveal,

busy, permanent, permit, sleepy, sure, respect, preserve, miser, rude, frequently, tardy, level, stormy, conservative, strict, ignorant, deceitful, exciting, motion, sinful, weary, rigid, genuine, proficient, impoverish, grand, result, imaginary, suspicious, precise, pride, unless, suave, forcible.

In the early use of opposites tests various methods of scoring were used. In some cases a time limit was set, and the scores calculated in terms of the number of stimulus words to which the correct responses were made. Other investigators, objecting perhaps to placing a time limit on the test, preferred to score the results in terms of the time required for the subject to complete the test, plus a penalty for each error or omission. In both of these methods no account was taken of the wide differences in the difficulty of the various stimulus words. Each error or omission was regarded as of the same value and the person tested was penalized the same amount regardless of the word missed. Clearly, if the best results are to be realized from the tests, the relative values of the different words must be taken into consideration in grading the responses. The previous study, while standardizing the *responses*, did not definitely evaluate the difficulty of the stimulus words in such a way as to make them readily usable in scoring results. With this in mind the writer attempted to secure such an evaluation for each stimulus word given in the list above,—this evaluation to be based on a large number of cases, and to be in terms of the difficulty of the word as indicated by the character and the accuracy of the responses given to it.

There are in general two methods that may be used in the determination of the values of these stimulus words. By the first method the values are determined in terms of the time required for the subject to respond to the stimulus word correctly. By the second the evaluation is determined on the basis of the percentage of accuracy of response for each word. It is quite likely that there would be a high correlation between the two procedures. That is, the words, that would require a long time on the average to elicit the correct response would in the long run be the ones that would

stand lowest in percentage of accuracy. The first method seems to offer certain possibilities where the subjects are to be tested individually. However, the gratifying results obtained from using the test as a group test, lead one to think that an evaluation based on the actual usage of the test would be more reliable. Accordingly, in the present study the second method was followed.

After having decided upon the method of evaluation the writer was then confronted with two further possibilities. The evaluation could be made directly in terms of the percentage of failures, or could be turned into percentile values by using the normal or probability curve as a basis. For the sake of comparison both procedures were carried through, although the results from the second method only will be presented here. The chief differences noted were that the easy words received a higher point value on the percentile basis, and the hard words a correspondingly lower value. For example, the first five words in Table I which are given a value .5 and .6 points were evaluated at .1 points by the first method, and *suave*, which is evaluated at 2.0 points, was given 2.4 points by the first method. The actual rank correlation between the results of the methods was almost perfect, "r" being equal to .996.

The stimulus words listed above were given in two groups to freshmen in the University of Iowa in the fall of 1916 and in 1917.* As a result of these investigations, responses from 990 individuals to the first half of the list, and 710 responses to the second half of the list were available. Using the King and Gold standardization as the key to the correct responses, these papers were corrected, and the responses to each stimulus word were tabulated.† In this tabulation the words given as *full value* were counted as *one*, and the *half value* words were counted as *one-half*. For example, if it was found that in responding to the stimulus word *to win*, 700 persons gave *to lose* (full value), and 72 gave *to fail* (half value), the total number of responses was counted as 736. In this way the totals were found for each of the eighty words in the list. Since these totals represent the number of correct responses, it is apparent

*In 1916 by James L. McCrory, and in 1917 by the writer, both under the direction of Prof. Irving King.

†Words given 2–3 value in the King and Gold table were given half value in this study, and all words counted as 1–3 by them were counted as wrong. This was mainly to save time by simplifying the procedure.

that the relative difficulty of the stimulus words is represented by the complement of these totals. That is to say, a word with a small total is more difficult than a word with a larger total. To secure the values on this basis the total number of correct and half correct responses were subtracted from the total number of possible responses, in this case 990. In the case of the words from the last half of the list for which there were only 710 responses available, the totals were increased in proportion as 990 is to 710, thus making all the words in the list comparable in spite of the differences in the number of possible responses.

These totals were turned into percentage of failure by dividing each by 990, the total possible responses. The percentage scores were changed directly into percentile values by reading directly from table based upon the area of the probability curve, assuming the base line to be broken off arbitrarily at $+3\sigma$. The particular abilities involved in this test are assumed to fit the probability curve, and the percentage of subjects who answer the various stimulus words correctly correspond to percentages of area under the curve from the 0 point to a point on the base line. This point on the base line in units of sigma was transformed into percentile values by setting 0 at $-3\sigma$, 50 at the mean, and 100 at $+3\sigma$. To illustrate the use of the table let us locate a word in the percentile scale. For example, the word *suave* was missed by 96% of the subjects.

From the table* a word missed by 96% of the cases is valued at 79. In this manner the percentile values were found for the 80 words.

These values were then totaled, and each value divided by the total, thus turning the percentile values into relative point values. These values range from .5 point for the words *beautiful* and *straight*, up to 2.0 points for the word *suave*. (See Table I.) It is evident that if the words were of uniform difficulty the point value of each word would be 1.25. Table I shows the words of the same point value grouped together in ascending order of difficulty. By making use of this table it is possible for one to compare directly the difficulty of the various stimulus words; or to select a number of tests of the same difficulty and uniformity. By using the complete list of eighty words and considering each word at its point value a test with a total possible score of 100 points is obtained. This is valuable where it is desirable to combine directly the results of the two opposites tests into one score.

*RUGG, H. O.—*Statistical Methods Applied to Education;* Houghton, Mifflin Co., Chicago, 1917. Table VI; pg. 396.

TABLE I

*List of Opposites Stimulus Words Arranged in Ascending Order of Difficulty with Point Values*

| Point Value | Stimulus words: | Point Value: | Stimulus words: |
|---|---|---|---|
| .5 | beautiful | 1.3 | level |
| | straight | | over |
| .6 | after | | refined |
| | increase | | respect |
| | remember | | rude |
| .7 | rough | | sleepy |
| | stingy | | strict |
| .8 | apart | | to reveal |
| | sell | 1.4 | active |
| | to float | | frequently |
| | take | | imaginary |
| .9 | generous | | injurious |
| | strength | | permit |
| | succeed | | rigid |
| | to lack | | to degrade |
| | vertical | 1.5 | conservative |
| | wild | | ignorant |
| 1.0 | cruel | | past |
| | innocent | | permanent |
| | part | | sinful |
| | simple | | weary |
| | to bless | 1.6 | exciting |
| | to win | | deceitful |
| 1.1 | busy | | genuine |
| | hindrance | | grand |
| | insignificant | | haughty |
| | miser | | motion |
| | preserve | | proficient |
| | sure | | result |
| | to hold | | suspicious |
| 1.2 | belief | | venturesome |
| | broken | 1.7 | animated |
| | despondent | | disastrous |
| | diligent | | impoverish |
| | silly | 1.8 | forcible |
| | stormy | | precise |
| | tardy | | pride |
| | tender | | unless |
| | to spend | 1.9 | serious |
| 1.3 | clumsy | 2.0 | suave |

It was of some interest to the writer to see the extent to which the standardization on the basis of the 990 responses was more reliable than the earlier standardization on the basis of the one hundred responses. A correlation was made between the list of eighty words as evaluated by King and Gold and by the present study. Using the Pearson method adapted to rank differences an "r" of .895 was found. The correlation between the two methods of evaluation discussed earlier in this paper was given above.

The stimulus words with their point values, full value responses, and half value responses, are shown in alphabetical order in the following pages for easy reference. The number preceding the stimulus word in each case is the *point value:* the stimulus word appears in small capitals, the full value responses in italics, and the half value responses in ordinary type.

1.4 ACTIVE: *passive, inactive;* slow, sluggish, lazy, quiet.
.6 AFTER: *before.*
1.7 ANIMATED: *lifeless;* spiritless, quiet, dead, sluggish, unanimated.
.8 APART: *together, with, joined;* near, adjacent.
.5 BEAUTIFUL: *ugly, homely.*
1.2 BELIEF: *disbelief, doubt, unbelief, distrust.*
1.2 BROKEN: *whole, smooth, mended, connected, continuous, intact;* continued, level, repaired, unbroken.
1.1 BUSY: *idle;* lazy, indolent, unemployed, unoccupied.
1.3 CLUMSY: *graceful;* agile, nimble, skillful, dextrous.
1.5 CONSERVATIVE: *radical, progressive, liberal;* hasty, reckless.
1.0 CRUEL: *kind, humane;* tender, gentle, kindly.
1.6 DECEITFUL: *frank, straightforward, sincere, ingenuous;* truthful, honest.
1.2 DESPONDENT: *happy, cheerful, hopeful, courageous;* gay, joyful, joyous, light-hearted.
1.2 DILIGENT: *lazy, slothful;* idle, careless, negligent, neglectful.
1.7 DISASTROUS: *fortunate, lucky, auspicious;* beneficial, helpful.
1.6 EXCITING: *quiet, quieting, soothing;* calming, monotonous, uninteresting.
1.8 FORCIBLE: *ineffective, powerless;* weak, gentle, mollifying.
1.4 FREQUENTLY: *seldom, rarely, infrequently;* occasionally, usually, almost-never.
.9 GENEROUS: *stingy, selfish;* miserly.
1.6 GENUINE: *spurious, counterfeit;* false, artificial, fake.
1.6 GRAND: *mean, simple, lowly, humble;* small, plain, poor, low, little, common, insignificant.
1.6 HAUGHTY: *humble;* low, lowly.
1.1 HINDRANCE: *help, aid, assistance, benefit;* advantage.
1.5 IGNORANT: *learned, knowing, informed;* wise, intelligent, well informed.
1.4 IMAGINARY: *real;* realistic.
1.7 IMPOVERISH: *enrich;* replenish.
.6 INCREASE: *decrease, diminish, lessen.*

1.4 INJURIOUS: *helpful, beneficial;* healthful, safe.
1.0 INNOCENT: *guilty;* wise, knowing, sinful.
1.1 INSIGNIFICANT: *important, significant, prominent;* great, grand, distinguished.
1.3 LEVEL: *rough, hilly, undulating, mountainous;* uneven, broken.
1.1 MISER: *spendthrift;* philanthropist, benefactor.
1.6 MOTION: *rest, repose;* quiet, inaction, inactivity, silence, quietness, at rest, quietude, quiescence, motionless.
1.3 OVER: *under, underneath;* below.
1.5 PAST: *future, coming.*
1.0 PART: *whole, unit, all, connect.*
1.5 PERMANENT: *transitory, transient, ephemeral, fleeting;* temporary, temporal, changing, changeable.
1.4 PERMIT: *refuse, forbid, hinder;* deny.
1.8 PRECISE: *inexact, inaccurate.*
1.1 PRESERVE: *destroy, spoil, ruin, waste, squander.*
1.8 PRIDE: *humility, self-abasement;* humiliation, humbleness.
1.6 PROFICIENT: *inefficient, incompetent;* deficient, incapable, unskilled.
1.3 REFINED: *coarse, rude, uncultured, crude, unrefined;* uncouth, uncultivated.
.6 REMEMBER: *forget.*
1.3 RESPECT: *despise, disrespect, dishonor, disregard, disdain;* scorn, abhor.
1.6 RESULT: *cause;* beginning.
1.4 RIGID: *lax, loose;* flexible, limp, relaxed, flabby, lenient, elastic, limber, pliable.
.7 ROUGH: *smooth, polished, plain.*
1.3 RUDE: *polite, courteous, refined, genteel;* cultured; gentle, cultivated, urbane, well-bred.
.8 SELL: *buy, purchase.*
1.9 SERIOUS: *frivolous;* gay.
1.2 SILLY: *wise, serious, sensible;* sober, sane, dignified.
1.0 SIMPLE: *complex, complicated, elaborate, intricate;* hard, difficult.
1.5 SINFUL: *sinless, holy, godly;* good, righteous, pure, innocent, virtuous.
1.3 SLEEPY: *wakeful;* awake, wide-awake, fresh.
.7 STINGY: *generous, liberal, lavish, free-hearted;* free, extravagant, spendthrift.
1.2 STORMY: *calm;* clear, peaceful, quiet, fair, still.
.5 STRAIGHT: *crooked, curved, bent.*
.9 STRENGTH: *weakness;* weak.
1.3 STRICT: *lax, loose, lenient, liberal;* careless.
1.1 SURE: *uncertain, doubtful, undecided.*
2.0 SUAVE: *impolite, brusque;* rough, rude, coarse, uncouth.
.9 SUCCEED: *fail.*
1.6 SUSPICIOUS: *trusting, trustful, unsuspicious, unsuspecting;* innocent, credulous, confiding.
1.2 TARDY: *punctual, prompt;* early, on-time, before-time.
1.2 TENDER: *tough, harsh;* hard, cruel, rough, hard-hearted.
1.0 TO BLESS: *to curse, to condemn, to execrate.*
1.4 TO DEGRADE: *to elevate, to uplift, to exhalt*
.8 TO FLOAT: *to sink.*

1.1 TO HOLD: *to let go, to drop, to let loose, to release, to loose, to loosen, to let fall.*
.9 TO LACK: *to have, to possess, to be supplied;* to abound.
1.3 TO REVEAL: *to hide, to conceal, to secrete;* to obscure.
1.2 TO SPEND: *to save;* to earn, to get.
.8 TO TAKE: *to give, to leave, to let go, to loose, to refuse.*
1.0 TO WIN: *to lose;* to fail.
1.8 UNLESS: *if.*
.9 VERTICAL: *horizontal.*
1.6 VENTURESOME: *careful, cautious;* cowardly, timid, afraid, fearful.
1.5 WEARY: *rested, refreshed;* fresh, refresh, rest.
.9 WILD: *tame, domesticated, civilized;* cultivated.

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100.0 points

# THE DIAGNOSTIC VALUE OF THE WOODY ARITHMETIC SCALES: A REPLY.

## PART II

W. W. THEISEN AND CECILE WHITE FLEMMING

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From a constructive point of view the criticism that the Woody tests do not diagnose may be answered by giving the results of typical analyses of performances for a number of classes.

*1. A sixth grade of 33 pupils tested in subtraction.*

The examples of the Woody Subtraction Scale, Series A, are shown below.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 6 | 2 | 9 | 4 | 11 | 13 | 59 | 78 | 7−4= | 76 |
| 5 | 0 | 1 | 3 | 4 | 7 | 8 | 12 | 37 | | 60 |

| (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) |
|---|---|---|---|---|---|---|---|---|
| 27 | 16 | 50 | 21 | 270 | 393 | 1000 | 567482 | 2¾−1= |
| 3 | 9 | 25 | 9 | 190 | 178 | 537 | 106493 | |

| (21) | (22) | (23) | (24) | (25) | (26) |
|---|---|---|---|---|---|
| 10.00 | 3½−½= | 80836465 | 8⅞ | 27 | 4 yds. 1 ft. 6 in. |
| 3.49 | | 49178036 | 5¾ | 12⅝ | 2 yds. 2 ft. 3 in. |

| (27) | (28) | (29) | (30) |
|---|---|---|---|
| 5 yds. 1 ft. 4 in. | 10−6.25= | 75¾ | 9.8063−9.019= |
| 2 yds. 2 ft. 8 in. | | 52¼ | |

| (31) | (32) | (33) | (34) | (35) |
|---|---|---|---|---|
| 7.3−3.00081= | 1912 6 mo. 8 da. | 5 2 | 6⅛ | 3⅞−1⅝= |
| | 1910 7 mo. 15 da. | ——=— | 2⅞ | |
| | | 12 10 | | |

The median score for the class on this test was 21.9, or more than three examples below standard. The type and frequency of error made by this class of pupils are shown in Table IV. The number of examples omitted by each pupil and the number of times any given example was omitted are also shown.

## TABLE IV

*Showing Number of Each Type of Error Made by Each of 33 Sixth Grade Pupils on the Woody Subtraction Test, Series A*

| | Pupils | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | Total |
| 1. Incorrect subtraction of denominate numbers | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 1 | . | 3 | 3 | 3 | 3 | 2 | .. | 3 | 3 | 3 | .. | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | .. | 3 | 3 | 3 | 75 |
| 2. Errors in subtraction of decimals due to incorrect placing when operation is indicated by minus sign | 1 | 2 | . | 2 | 3 | 3 | 3 | . | . | 1 | 1 | 2 | 2 | 2 | .. | .. | 3 | 3 | .. | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 3 | 2 | 3 | .. | 3 | 1 | 2 | 59 |
| 3. Incorrect subtraction of fractions when both minuend and subtrahend contain fractions | 1 | . | 3 | . | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | .. | .. | 2 | 1 | 2 | .. | 2 | 4 | 1 | 4 | 2 | 2 | 2 | .. | 3 | 1 | 1 | 3 | .. | 4 | 50 |
| 4. Not reducing fractional answer | 3 | 3 | . | 3 | 3 | . | 3 | . | 1 | .. | 3 | .. | 1 | 2 | 2 | 1 | 1 | 3 | .. | 2 | 1 | 2 | 2 | 1 | 1 | .. | 3 | 3 | .. | .. | 1 | 3 | 2 | 50 |
| 5. Wrong operation | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 26 | 1 | 4 | .. | .. | .. | .. | 2 | .. | .. | .. | .. | .. | .. | 4 | .. | .. | .. | .. | 37 |
| 6. Subtracting as if not borrowed | . | . | . | 3 | . | . | . | . | . | . | . | 3 | . | . | . | . | 8 | .. | 2 | 3 | .. | 1 | .. | 2 | 1 | . | . | 3 | 1 | .. | 3 | . | . | 30 |
| 7 Subtracting as if borrowed | 3 | . | . | 1 | 2 | . | . | . | . | . | 1 | . | . | 3 | . | . | . | 3 | .. | 2 | .. | 4 | 5 | . | . | . | . | . | 3 | 2 | . | . | . | 29 |
| 8. Error in fundamental combinations | . | . | 2 | . | 1 | . | 1 | . | . | . | . | 2 | .. | 3 | .. | 2 | .. | 1 | .. | 2 | 2 | .. | 3 | 1 | . | . | 1 | 1 | 1 | . | . | 1 | 2 | 26 |
| 9. Omission of, or incorrect placing of decimal point | 2 | . | . | 2 | 3 | . | 2 | . | . | 1 | 1 | 1 | 1 | 1 | . | . | 1 | 1 | .. | 1 | . | . | 1 | . | . | . | 2 | . | 3 | . | 1 | . | 2 | 26 |
| 10. Incorrect subtraction of fraction from whole number or vice versa | 1 | 1 | 1 | . | 3 | 1 | 1 | . | 1 | 1 | . | . | 1 | 1 | .. | 1 | 1 | 1 | .. | 1 | 1 | 1 | 1 | . | . | . | 1 | 1 | 1 | .. | 1 | 1 | 1 | 25 |
| 11. Failure to recognize the sign of operation | 1 | 1 | 3 | 1 | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | .. | 8 |
| 12. Failure to classify result | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| Number of examples omitted | 1 | . | 4 | . | . | . | . | 1 | 2 | 3 | . | . | . | 4 | 5 | 4 | . | . | 6 | . | . | 1 | . | . | 1 | . | . | . | 1 | 6 | . | 2 | 1 | 42 |

Note: The examples omitted were No. 24 four times, 25 once, 26 twice, 27 twice, 28 five times. 30 seven times, 31 nine times, 32 three times, 33 seven times, 34 and 35 each once.

The greatest number of errors, 75 out of a total of 99 chances, was made in examples in subtraction of denominate numbers. Apparently this was due to the omission of this subject matter from the course of study. Reference to the original tabulation sheet indicating scores by pupils for each example shows that two pupils solved all three of the examples in subtraction of denominate numbers. Two others had two of the three correct. When the subject of denominate numbers is presented as a topic to this class, shall these pupils who apparently already possess the ability to subtract denominate numbers be asked to spend the same amount of time on the subject as do the other 29 who have need of this instruction? Has our analysis thus far revealed anything as to the needs of different pupils in this class? Has the test helped us to diagnose to the extent of revealing the presence of certain abilities in certain pupils of the class?

The second most common source of error occurred in examples 28, 30, 31. These are:

$10-6.25=$ , $9.8063-9.019=$ , and $7.3-3.00081=$

In each of these the operation is indicated by the minus sign. Fifty-nine errors out of a possible ninety-nine were made in these examples because of incorrect placing of the subtrahend with respect to the minuend in performing the subtraction. Twenty-eight pupils contributed errors of this sort. In answer to Example 28, 6.15 was common, obtained by disregarding denominations, placing the 10 under the .25 and then subtracting. In example 30, the answer 8.9044 often occurred. This is obtained through a manipulation such as this

$$\begin{array}{r} 9.8063 \\ 9.019 \\ \hline 8.9044 \end{array}$$

3.00008 occurred several times in answer to $7.3-3.00081=$ . This remainder is obtained by placing the 7.3 directly under the 81 of the subtrahend which is then treated as the minuend. The recurring incorrect answers to these examples due to the same cause were several, depending on where the pupil chose to place the respective figures.

Fifty errors occurred through inability to subtract correctly numbers with fractions (either mixed or pure fractions) and an equal number of errors through failure to reduce to lowest terms, or through errors in reduction. The latter type is made up of ex-

amples in the subtraction of fractions in which the operation was correctly performed, but in which answers either were not reduced (*e.g.*, $2^2/_8$ occurs often in answer to example 35, which is $3\frac{7}{8} - 1\frac{7}{8} =$ ) or were incorrectly expressed as $2^2/_8 = \frac{1}{4}$. Thus fifty errors, or an average of more than one per pupil, were made by this class by reason of the fact that the teacher had neglected to teach the class to express answers in lowest terms. Only nine of the class did not make an error of this sort. Ten made three errors each.

Twenty-five errors were due to difficulties in subtracting a fraction from a whole number or vice-versa, *e.g.*, in examples 20 and 25, $2\frac{3}{4} - 1 =$ and $27 - 12\frac{5}{8} =$ . Example 20 was missed in all six times, and example 25 twenty-four times. It is significant that for example 25 the answer was given as $12\ \frac{5}{8}$ by fourteen of the class. Another gave $15^0/_8$. The recurrence of the same error is sufficient to indicate a type of subtraction in which the class has not yet attained proficiency.

What seem to be two common and somewhat similar sources of error appear in the subtraction of whole numbers. In one the pupil treats a figure of the minuend as if he had previously borrowed from it when he really has not. In the other he proceeds as if he had not borrowed when as a matter of fact he has. This type of error occurs most frequently in examples 19 and 23:

$$\begin{array}{rcr} 567482 & \text{and} & 80836465 \\ \underline{106493} & & \underline{49178036} \end{array}$$

Twenty-nine of the former and thirty of the latter were found. It is granted, of course, that this classification may include pure errors in combination. In both types errors were limited to eleven pupils. Of the type in which pupils subtracted as if they had not borrowed, eight errors were made by one pupil. Five others made three each. These pupils at any rate reveal a need of drill in subtraction of whole numbers with and without borrowing. It is an interesting fact that seven of the eleven pupils who made errors through subtracting as if they *had* borrowed made no errors of subtracting as if they *had not* borrowed. Seven of the eleven who made the latter type of error did not make the former. These facts are at least highly suggestive of individual needs in the way of drill for the removal of specific weaknesses in subtraction. How many more

errors does the pupil who made eight errors of the first of these types need to make before it can be said that we have located one of his specific needs?

Omitting the decimal point or incorrectly placing it occurred in examples 21, 28, 30 and 31. Twenty-six errors of this type were contributed by seventeen pupils. Two pupils made three errors each of this type. Little is indicated as to the specific needs in subtraction of pupil 15 who contributed 26 of the 37 cases listed under "wrong operations" and omitted 5 other examples. However, the teacher may well observe the habits which this pupil and also pupils 17 and 29 are forming toward following specific directions. Individual attention to the physical condition and mental capacity of these children and further testing would result in a more adequate diagnosis of their difficulties.

Thus we have diagnosed marked weaknesses of this class to the extent of discovering: (1) The inability of this class to add denominate numbers; (2) a habit of disregarding denominations in subtracting decimals when the sign of operation is expressed by a minus sign; (3) weaknesses in subtraction of fractions—fractions from fractions, and fractions from whole numbers or vice-versa; (4) failure to express answers in lowest terms; (5) weakness in placing the decimal point; and (6) errors in borrowing.

*2. A fifth grade of 41 pupils tested in subtraction.*

The median score for this class was 21.2 or .8 above the Woody standard.

At first glance one might conclude that this class is doing satisfactory work since the median score exceeds the standard established by the author of the test. But careful analysis of individual results shows tendencies to error, the correction of which would increase the efficiency of the class as well as that of particular individuals.

Nearly half the class found borrowing a source of difficulty. Thus, nineteen pupils apparently subtracted as if they had not borrowed. This inaccuracy gave rise to 31 errors. Seven pupils made errors due to subtracting as if borrowing had taken place when it had not. Even though some of these errors may be attributed to incorrect combinations, the analysis suggests that a number of this class might profit from some well directed practice drill in subtraction with borrowing.

On the surface this class tested in April appears weak in ability to subtract fractions. Example 24, $8\frac{7}{8}$ / $5\frac{3}{4}$, was solved correctly but seven times; 25, $27$ / $12\frac{5}{8}$, not at all; 29, $75\frac{3}{4}$ / $52\frac{1}{4}$, six times; 33, $\frac{5}{12}-\frac{2}{10}=$, once; 34, $6\frac{1}{8}$ / $2\frac{7}{8}$, three times; and 35, $3\frac{7}{8}-1\frac{5}{8}=$, four times. However, thirty-four errors were made on examples 24, 29, 34 and 35, due *not* to inability to perform the necessary subtraction, *but to failure to reduce answers to lowest terms.* These were contributed by twenty-two pupils. Evidently reduction to the lowest terms had not been sufficiently emphasized by the teacher. The fact that no one solved example 25 seems to indicate that these pupils had not been taught how to subtract a fraction from a whole number. Seven pupils gave $23\frac{2}{0}$ as an answer to example 29. These children apparently do not know the significance of a denominator.

While, as Woody maintains, the tests are not safe criteria for the judgment of individual abilities, yet the performances of individual pupils are sometimes so markedly below or above the performances of the class as to furnish a reasonably accurate diagnosis of the achievement of these individuals. In this fifth grade there was one girl for whom drill on examples in subtraction of fractions such as represented in numbers 24, 29, 33, 34 and 35, would be largely waste of time since she solved all of them correctly. She solved thirty of the thirty-five examples correctly, but failed on three examples involving decimals, numbers 28, 30 and 31. Moreover, she was the one pupil in the class able to solve both numbers 26 and 27, examples in subtraction of denominate numbers. Her needs were not the same as those of the larger part of the class. She could possibly profit if permitted to take sixth grade arithmetic. Further evidence on the wisdom of such promotion in arithmetic could be found by consulting her record on the tests in addition, multiplication, and division.

A pupil may easily be misjudged by taking only his gross score into account. One boy had only six examples correct owing to the fact that he had multiplied in all examples possessing a single digit in the minuend.

Minor deficiencies of this class are indicated by errors made by three pupils who put down a cipher in subtracting a cipher from an integer, and errors by four pupils on example 10, $7-4=$ .

*3. A third grade class of 29 tested in addition.*

The median for this class was 16.7 or 2.2 points above Woody's standard.

Among the first 16 examples the most troublesome were number 7, $3+1=$ , missed 14 times; number 8, $2+5+1=$ , missed 13 times, and number 14, $25+42=$ , missed 21 times. A number of this class are clearly in need of reviewing this type of exercise. Eight pupils did not miss either of the three examples. These very likely need no drill on such processes. Ten gave "3" as the answer to example 7. Seemingly the + sign was mistaken for the sign of multiplication. "10" was given as the answer to example 8 four times, and "11" was given as the answer 3 times. The former may occur through multiplying the 2 by the 5, disregarding the 1, while in the latter case the process seems to be the same except that the one is added. "13" occurs three times as the answer to 14, and "31" occurs twice. The former is arrived at by adding all of the figures and the latter by adding the 2 to the 4 and then adding the result to the 25.

Only a very little attention on the part of the teacher should be necessary to remedy the weaknesses of the class in examples of this sort. The errors were due not to a lack of knowledge of the fundamental addition combinations, but to an incorrect mental "set." The bonds formed were very often correct for the process which the child set out to perform. As previously stated, distinction must be made between an error and the mental process causing the error. A number of the errors in this class are quite clearly errors in carrying. Pupil 12 fails entirely on this process. In six different examples each of which requires carrying he adds every column of each correctly with the exception that he disregards entirely the figures to be carried. He made no errors on examples requiring only simple column addition.

Pupil 24, a nine year old girl, differs radically from the other members of the class in the type of process she can manipulate. While she had only a median number correct, she was able to add correctly the fractions in examples 23, 25 and 28, which are $^1/_3+{}^1/_3=$ , $^3/_8+{}^5/_8+{}^7/_8+{}^1/_8=$ , $^3/_4+{}^1/_4=$ , but did not reduce to lowest terms in the latter two. She solved also example

24, 4.0125
1.5907
4.10
8.673

involving decimals and example 20, $12.50, in U. S.
16.75
15.75

money. Her errors on two other examples in addition of U. S. money, (numbers 19 and 21), were due to incorrect addition and not to difficulties offered by U. S. money. She is a pupil whose score on a test of this sort would be raised by an acquisition of the ability to recognize the sign of operation in examples 7, 8 and 14. Seven pupils in this class solved example 24 in addition of decimals, and nine solved example 21, $24\frac{1}{2}$. Future teachers of this class should ascertain which of the pupils will need only a very limited additional teaching to make them proficient in addition of examples in decimals and in U. S. money.

*4. A fourth grade of 30 pupils tested in addition.*

This class scored 21.7 or 3.4 above the Woody standard.

Examples 7, 8 and 14 again offer a difficulty to this class in recognizing the sign of operation. Seven errors were made on these three examples. Three pupils made two each. These children show signs of weakness in examples of this type. The record sheet of individual scores by examples reveals some pupils already strong in addition of fractions and decimals, and for whom indications seem to point that it would be a waste of effort to spend time later in developing these processes. Examples like number 23 or number 25, are not too difficult for four of this class. Sixteen, or more than half of the class, solved number 22, an example in addition of three long columns of figures. Pupil 3 added correctly every example in decimals including those in U. S. money. Pupil 13 on the other hand, while able to solve the three examples in U. S. money, failed on examples 24, 31 and 33 in decimals. But this same pupil had examples 23, 25 and 28 in addition of fractions correct. He appears to be able to add fractions of the same denomination. The highest score in the class, 27 correct, was made by pupil 14, a nine year old boy who has already skipped a half grade. He had examples 23, 25, 28, 29 and 32 in addition of fractions correct. In fact, he made only one mistake on the first 25 examples. He was charged with an error on example 2 on account of omitting the dollar sign. Little further teaching effort will be needed to make him proficient in addition of fractions and decimals.

The poorest score in the class was 13 correct made by a 14 year old girl. She missed examples 8, 11, 14, 16 and 17, solved example 18 correctly, and had none correct from there on. Her answer to example 8, 2+5+1= was "11." Her answer to example 14, 25+42= was "49," obtained by adding the 2's and then adding the 4 to the 5. In the other examples attempted and missed, up to number 23, the error was in addition. Her difficulty appears to be in carrying, for the first column in 5 of the 7 incorrect examples in column addition was added correctly.

The illustrations of class diagnosis so far given are only typical of what may be discovered through the Woody tests. Additional illustrations might be given for each grade in each of the four fundamentals. Those already given should be sufficient to indicate the type of service which these tests may perform. Through the use of the tests and by an analysis of the performances on them, weaknesses in particular types of examples may be discovered. Not infrequently it is possible to discover the particular mental process operating in the minds of children to prevent the correct solution of a certain type of example. Often unusual proficiency is revealed and methods of further development can be discovered. The need of differentiated drill which shall provide one type of practice exercise for some of the class and another for other members, even though all may be about equal, can often be brought out. Such discoveries furnish points of attack for the teacher and the supervisor and make for increased efficiency in teaching. The illustrations in class diagnosis given above show that even though a class may be above the standard for its grade, very often marked weaknesses in simple processes are present, which if remedied would permit of a much higher score.

From the standpoint of a superintendent or a supervisor it is often desirable to locate weaknesses which may be rather common for the system as a whole. For this purpose a test must be sufficiently brief so that an undue amount of clerical labor shall not be required to discover the desired facts. At the same time the test must be sufficiently comprehensive to include a variety of types of examples in order that a reasonably detailed diagnosis may be made. Both of these requirements are met by the Woody tests. How the tests may be used by a supervisor to discover something as to the teaching needs in a number of schools of the same system may be judged from the two tables following. Table V, from the survey of the

TABLE V

*Ten Troublesome Examples in Grade VIII*

| Examples | Standard* | Percent of pupils who solved each of ten examples correctly—for the city and by buildings | | | | | |
|---|---|---|---|---|---|---|---|
| | | Buildings | | | | | |
| | | City | 1 | 2 | 3 | 4 | 5 |
| $2 \div 2 =$ | 86.7 | 71.9 | 64.5 | 61.1 | 89.7 | 71.4 | 69.7 |
| $2.1\overline{)25.2}$ | 79.9 | 67.6 | 61.3 | 66.7 | 65.5 | 75. | 69.7 |
| $25\overline{)9750}$ | 87.8 | 77.7 | 74.2 | 77.8 | 79.3 | 82.1 | 75.8 |
| $.003\overline{).0936}$ | 73.2 | 53.2 | 35.5 | 55.6 | 65.5 | 46.4 | 72.7 |
| $3\frac{1}{2} \div 9 =$ | 59. | 33.8 | 35.5 | 5.6 | 34.4 | 42.9 | 39.3 |
| $\frac{3}{4} \div 5 =$ | 57.7 | 51.1 | 48.4 | 27.8 | 51.7 | 64.3 | 54.5 |
| $\frac{5}{4} \div \frac{3}{5} =$ | 59.6 | 33.8 | 38.7 | 16.7 | 34.5 | 32.1 | 39.4 |
| $52\overline{)3756}$ | 46.9 | 45.3 | 38.7 | 61.1 | 41.4 | 57.1 | 36.3 |
| $531\overline{)37722}$ | 25.1 | 28.1 | 25.8 | 33.3 | 27.6 | 32.1 | 24.2 |
| 9)69 lbs. 9 oz. | 25.7 | 18 | 35.5 | 5.6 | 3.5 | 25. | 15. |
| No. pupils taking test | | 139 | 31 | 18 | 29 | 28 | 33 |

Janesville, Wisconsin, schools,† gives the per cent. of eighth grade pupils in each building who solved each of ten examples of the division scale correctly.

Possibly few eighth grade teachers would be willing to admit previous to a test of this sort that their pupils could attain averages on these examples no greater than did the 139 children shown in Table V. Through the application of the test a supervisor can avoid personal criticism of a teacher for her poor success. It becomes unnecessary as the facts speak for themselves. There are perhaps few teachers who would not be stimulated to immediate efforts to remedy the shortcomings of their pupils here revealed. No true teacher would knowingly ignore a condition where only 72% of the pupils in the eighth grade solve examples like $2 \div 2 =$ . Yet this was an undiscovered condition existing in this city previous to the test. Many gave 2 or 0 as answers. That an example like $\frac{5}{4} \div \frac{3}{5} =$ was beyond two-thirds of the eighth grade or that

*Computed from Table XXX of Woody's monograph. See Tables III and XXXI for key to corresponding orders of examples.

†*An Educational Survey of Janesville, Wisconsin.* State Dept. of Education, Madson, Wis.

only 45% of them could solve the example $52\overline{)3756}$ correctly was perhaps undreamed of by teachers and supervisors in this city. None of the buildings of Table V performed as well as one might desire on any of the examples, even though certain of them exceeded Woody's standard in some instances.

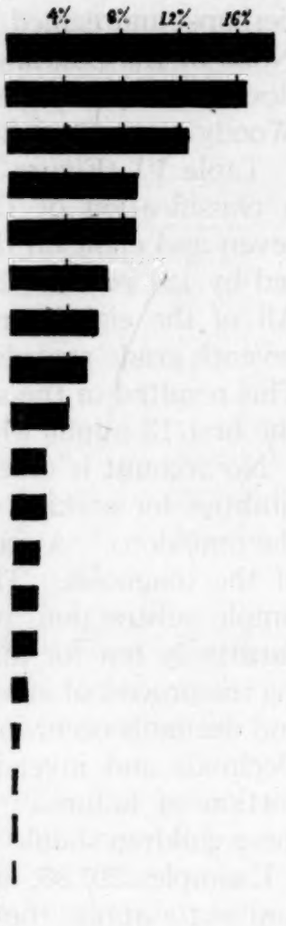
Table VI (Figure III), also taken from the Janesville survey, is a classification of 1500 errors on examples attempted in grades seven and eight on the division scale. These errors were contributed by 181 pupils, 43 from grade seven and 138 from grade eight. All of the eighth grade papers were first included and sufficient seventh grade records were then added to make the necessary 1500. This resulted in the selection of one seventh grade of 30 pupils and the first 13 pupils whose papers were drawn from a second.

No account is taken here of the difference in the number of possibilities for making each type of error on the division test nor of the omissions. A record of these facts would add to the precision of the diagnosis. There are many chances for making errors in simple subtraction, multiplication, division and placing, but comparatively few for making certain others. Opportunity for applying the process of inverting the divisor is offered in only five examples and decimals occur in five, though they may be used in some others. Decimals and inversion of fractions, however, cause a large proportion of failures. Evidently the prescription of drill work for these children should center more on these processes than on others.

Examples 29, 30, 31, 32, and 34 of the division scale offer opportunity to apply the process of inverting. These examples are: $3\frac{1}{2} \div 9 =$ , $\frac{3}{4} \div 5 =$ , $\frac{5}{4} \div \frac{3}{5} =$ , $9\frac{5}{8} \div 3\frac{3}{4} =$ , $62.50 \div 1\frac{1}{4} =$ . 277 errors out of 905 ($181 \times 5$) opportunities were made in this process. In addition 68 omissions were recorded. There were 187 cases of incorrect solutions on account of other errors in the work or on account of errors in other operations which pupils attempted to substitute for inverting—the most logical process to use—*e.g.*, in example 34 several reduced the divisor to a decimal, 1.25, and then erred in division of decimals. Only 7 of the 181 children made no errors of any kind on either of the five examples. If we add the 277 and 68 (which we may do since ample time is allowed for the test), we have at least 345 errors that may fairly be charged to insufficient facility with the process of inverting. That is 38 per cent. of the opportunities were failures on account of omission or inability to manipulate the process. If

Table VI. FIGURE III

| | No. | % |
|---|---|---|
| 1. Incorrect Inverting or Failure to Invert | 277 | 18.46 |
| 2. Incorrect Division | 246 | 16.4 |
| 3. Incorrect placing, of, or omitting of decimal point | 189 | 12.6 |
| 4. Failure to reduce or incorrect reduction of remainder or answer | 133 | 8.87 |
| 5. Incorrect division of denominate numbers | 132 | 8.8 |
| 6. Omitting or adding cipher in quotient | 101 | 6.73 |
| 7. Not completing division | 92 | 6.13 |
| 8. Incorrect subtraction | 81 | 5.4 |
| 9. Incorrect multiplication | 61 | 4.07 |
| 10. Using incorrect denominator of remainder | 36 | 2.4 |
| 11. Failure to classify result | 35 | 2.33 |
| 12. Failure to employ both parts of fraction | 29 | 1.93 |
| 13. Incorrect placing or bringing down | 28 | 1.87 |
| 14. Incorrect reduction of mixed numbers | 28 | 1.87 |
| 15. Failure to recognize the sign of operation | 15 | 1. |
| 16. Incorrect addition | 7 | .47 |
| 17. Error in copying | 4 | .27 |
| 18. Illegible answer | 4 | .27 |
| 19. Incorrect cancellation | 2 | .13 |
| Total | 1500 | 100% |




time permitted one might readily determine how many of the 187 other errors occurred in substituted processes. It is safe to say that at least 40 per cent. of the total chances on these examples resulted in failure either directly or indirectly because of insufficient familiarity with the process of inverting. These are significant facts for the supervisor. The diagnosis has revealed one marked weakness in arithmetic work in this school system. If desired, one might record the percentage of error separately by classes, *e.g.*, in the seventh grade class of 30 pupils there were 58 errors in attempted use of the process of inverting, and 14 omissions, making an efficiency of but 52%, $(150-72)\div 150$, in the attempted use of this process. The errors were contributed by 23 pupils. Three pupils made 5 errors, four made 4, three made 3, five made 2, and eight made 1. In one eighth grade of 31 pupils there were 42 failures contributed

by 23 pupils in attempted use of the process of inverting, and 16 omissions or an efficiency of 62%, (155 − 58) ÷ 155. While the showing is still unsatisfactory, it indicates a higher proficiency than that of the seventh grade above.

Omission of a cipher in the quotient was another deficiency of the group of children who contributed the errors of Table VI. Examples 18, 21, 23, 24, and 25, $13\overline{)65065}$, $25\overline{)9750}$, $23\overline{)469}$, $75\overline{)2250300}$, $2400\overline{)504000}$, involve ciphers in the quotient. The 181 children made 101 errors of this type. In the seventh grade group of 30 pupils 9 made no errors by reason of omitting a cipher in answer to one or the other of these examples, another added an extra cipher in one, and four others omitted one or more of the examples entirely. Ten of the grade appear to be definitely weak in examples involving ciphers in the quotient. These ten failed on two or more of the five examples either through omitting a cipher or omitting the example altogether. The performances of each of the other classes on these examples might be analyzed similarly.

Example 23 serves as a good index not only of whether pupils have mastered the difficulties offered by a cipher occurring in the quotient, but of whether they have formed the important habit of estimating answers. Six of the thirty pupils in the seventh grade class above gave $2^{9}/_{23}$ as an answer. Evidently they have not been taught to estimate answers habitually. As we have stated before, it is not so much a question of how many errors, but what do the errors reveal. "It isn't the fact that you're dead that counts, but how did you die."

That a single example may sometimes be sufficient to reveal distinct sources of weakness, may be seen from the results for this same seventh grade class on example 28 of the division test, $.003\overline{).0936}$. The errors on this example reveal an unsatisfactory development in ability to divide one decimal by another. Only nine of the class had the correct answer 31.2. Seventeen failed because of inability to manipulate the necessary operations. Three others omitted it entirely apparently for the same reason. One other made what seems to have been a careless error in expressing the quotient as 21.2. Only two of these 17 errors could possible be explained on the basis of being due to a careless omission of the decimal in the quotient. These obtained 312 as an answer. Two gave an answer .0000312 (obtained by pointing off the sum of the places

in the dividend and the divisor), one .00312, five .0312, one 301.2, one .12½, one .123, one 13, one 2, one .209 $^{9}/_{003}$, and one .9. The last six of these were obtained through an attempt to solve the problem in some such manner as this:

$$
\begin{array}{r}
.12\frac{1}{3} \\
.003)\overline{.0936} \\
\underline{.003} \\
\overline{906} \\
\underline{006} \\
\overline{900} \\
300 = \frac{1}{3}
\end{array}
$$

It is significant that 16 of the 17 above also missed example 20 $2.1\overline{)25.2}$ but did not fail on either examples 22 or 26 which are: $2\overline{)13.50}$ and $12\overline{)2.76}$. Eight of the nine who had example 28 correct had also 20, 22, and 26 correct. Of the three who omitted example 28 one omitted all four of the group and the other two solved examples 22 and 26 correctly but failed on number 20. The boy who erred in division on example 28 solved the other three correctly. Thus at least 19 of this class appear to be weak in dividing one decimal by another of the type in examples 20 and 28 and 9 appear strong.

In his criticism of the Woody scales the writer of the article referred to in Part I omits all analysis of the types we have just shown. Yet it will be recalled that he stated as his purpose, "to learn how completely it is possible for these scales to diagnose a class and how accurate is such diagnosis as they make." He attempted to prove his major thesis that the tests do not afford a satisfactory diagnosis by offering certain objections. His principal objections were that the scales do not contain all types of examples or a sufficient number of those types; and that the statistical rather than the analytical method was used in their selection. His supporting evidence was limited almost entirely to a comparison of the percentage of examples correct for given types with figures showing the average number of similar examples solved on the Cleveland Survey Tests,—a rather faulty comparison at best. We submit the illustrations which we have just given in Part II of this paper as evidence in favor of the Woody Scales which can not be overlooked in any consideration of their diagnostic merits.

# DISCUSSIONS AND COMMUNICATIONS

## SOME RESULTS WITH THE HAHN-LACKEY SCALE IN GEOGRAPHY

During the past few months, the writer, with the assistance of two of his graduate students who are engaged in teaching geography in elementary schools, has been able to make some studies with the Hahn-Lackey scale.* No opportunity has been found as yet to extend the study over many schools, but it is expected that this may be done eventually.

The making of a scale, and, no less, the use of one, in geography, offers problems of peculiar difficulty. It would seem that only through careful and repeated testing of the scale, can any real progress or betterment in its construction be brought about.

The objects of the work done with the scale were:

(a) To stimulate geography teaching by emphasizing some minimum essentials.

(b) To enable certain students of teaching to form some general notion about the quality of geography teaching in their schools.

(c) To study the scale itself by using it.

### Schools Giving the Test

For convenience, the present report will give the results noted in three schools, to be designated hereafter as A, B, and C, respectively.

*School A* is a good sized school in an eastern city. Thirty-seven per cent. of its pupils are foreign born—Italians and Russian Jews. 460 children in grades four to eight were tested, using steps M, P, Q, S, W, U and V of the scale.

*School B* is a very large school of 3600 children located in the same city as *A*. More than one-third of the children are Hebrews. One-tenth are of Italian birth. In this school there are from seven to ten classes in each grade, therefore there was ample opportunity to test children of supposedly equal attainments. 1595 children, in grades four to eight, were tested with the very simple steps W and X of the scale. 799 pupils were tested with step S.

*School C* is a summer school for children in a college town in the East. These children were of typical American stock. 116 pupils in grades four to seven were tested.

The writer would direct attention to the fact that the present report is based on answers written by 2970 children. In making the entire scale, papers from 1696 children were used by Hahn and Lackey.

*Vide Jour. Geog., Vol. XIII, No. 5, January 1918.

## STEPS OF THE SCALE USED IN THIS INVESTIGATION

### *Step M*

90. How could you go to Asia if you wished to make that trip?
93. Name two large rivers of Asia.
111. How can one go by boat from the Hudson River to Lake Erie?
133. Give two reasons for the importance of the Columbia River.
136. Name two of the most important materials shipped on the Great Lakes.
155. Give the capitals of Japan and China.
159. Name five important inland cities of Europe.
212. Draw a map of your state, and locate in it two rivers, the capital, and the largest city.
214. Name the state or territory in which each of the following is located: Galveston, Washington, St. Paul, Sitka, Savannah, Spokane.
199. What disadvantage do the people of Great Britain suffer as to food supply?
109. Why do the rivers of New England furnish water power for manufacturing?
135. Why is the Rio Grande an important river?
138. Give two reasons why cities usually grow up at falls in rivers.
146. Give two reasons why Argentina exports wheat to Brazil rather than to the United States.
165. What part of Asia is similar to Canada and in what way is it similar?
188. Since the larger part of our iron ore is mined in Minnesota, why is little iron and steel manufactured there?
117. Why does the earth not look round to us?
76. Why are so many hogs raised in the United States?

### *Step P*

79. Name two large rivers in South America.
80. What two important products are brought to us from Brazil?
88. How can you get from New York to London, and in what direction would you go?
89. How can steamboats go from New York City to San Francisco by the shortest route?
100. Name the chief occupation of the people of Australia.
105. Give two reasons why mountainous regions are not good for farming.
28. How can we tell how big a country is by studying a map?
10. How long does it take the earth to go around the sun?
67. Give the principal reason why such dense forests grow along the Amazon River.
70. Which part of the United States is most important for manufacturing and which for agriculture?
74. Where may snow be found in the hot belt near the equator?
77. Why is there so little rainfall in the Great Basin of the U. S.?
78. Name one way in which the Panama Canal will be an advantage to the United States in its trade with South America.
81. During what months does Argentina have winter?
82. In what industry or kind of work are most of the people of England employed?
31. Why do so few people live in deserts?

*Step Q*

60. Name four fur-bearing animals.
36. Name four large rivers of Europe.
99. What two countries of Asia are noted for tea?
129. Give the capitals of Colorado and Massachusetts.
42. Name two kinds of food that we get from animals.
1. From what country do we get much of our coffee?
12. Which is the largest and which is the smallest, the moon, the sun, or the earth?
71. What country of South America has a climate simliar to ours?
103. Why is it warmer in New Orleans than in Chicago?
104. Why are camels such useful animals for traveling in desert places?
1. What is the cause of day and night?
18. What do the rivers do with the soil that they carry?

*Step S*

52. What is the largest city of your state?
64. Where is Alaska and to whom does it belong?
84. Name four large cities of Europe.
92. Give the capitals of France and Germany.
101. Name two large bodies of water that border on Florida.
45. Name four things you use for food that do not grow where you live.
68. Give one reason why so many of the great cities of the United States are near the sea coast.
72. Which is the coldest and which the warmest part of South America.

*Step U*

63. What country is north of the United States and to whom does it belong?
102. Name two other countries in North America besides the U. S. A.
24. Name five wild animals.
5. What two oceans border on the United States?
43. Name a plant used for making cloth.
49. Write your whole address.
27. Name two kinds of work that men do in getting materials for building houses.
26. Name two kinds of work that men do in getting food for us.
34. How can you tell from what direction the wind is blowing.
50. To whom do the streets or roads belong?

*Step V*

59. In what direction do you live from the equator?
64. Name two important mountain ranges of the United States.
11. Name the four reasons.
33. What is the direction half way between south and west?
8. In what direction would you go to go to Canada?
15. What is the capital of the United States?
25. Name an animal useful to man in desert countries.
65. Why is there not much farming in Alaska?
22. How do we know that there is air?
4. Why is the Arctic Ocean not much used by sailors?
40. How does the ocean help to furnish us food?
30. Why are there more birds here in summer than in winter?

*Step W*

32. In what direction are you facing when your back is toward the north?
51. What is the capital of your state?
17. Name two things that plants must have to live.

*Step X*

2. Name two animals used by the Eskimos.

NOTE: All numbers prefixed to the above questions correspond to the numbers given to the questions in the original scale as published by the authors.

## RESULTS OF THE TESTS

Below are given the tabulated results as calculated for the three schools.

SCHOOL A

| Grade | Step | Number of Pupils Taking Test | Per cent. Obtained | Per cent. called for on scale | Remarks |
|---|---|---|---|---|---|
| 8th | S | 33 | 86.1 | 88 | General failure on question 45.* |
| 8th | S | 29 | 72 3 | 88 | Did poorly on question 68.* |
| 8th | Q | 32 | 78.2 | 79 | Failed on rivers of Europe. |
| 8th | P | 26 | 65.5 | 73 | Nearly all failed on question 81; many on 105.* |
| 8th | M | 34 | 68.4 | 50 | |
| 8th | M | 33 | 57.8 | 50 | |
| 7th | P | 30 | 60.4 | 73 | Nearly all failed on questions 81;* many on 105.* |
| 7th | P | 28 | 57.1 | 73 | Ditto |
| 7th | M | 32 | 43.7 | 50 | |
| 6th | P | 40 | 48.8 | 58 | Nearly all failed on question 81;* many on 105.* |
| 6th | M | 38 | 34.7 | 34 | |
| 5th | U | 30 | 74.0 | 84 | Questions 26* and 27* were general failures. |
| 4th | W | 38 | 82.4 | 84 | Failed on food plants need |
| 4th | V | 37 | 76.2 | 79 | Failed on 65* and 22.* |

Total number tested—460 pupils.

*For these questions see above.

SCHOOL B

NOTE: A and B under "Grade" mean respectively the first half and second half of the year indicated. Results with step X (1595 papers rated).

| Grade | No. getting zero | No. getting 50% | No. getting 100% | Total No. of Pupils | Average percent obtained | No. of Papers | Average % obtained | Percent called for on scale |
|---|---|---|---|---|---|---|---|---|
| 8B | 0 | 14 | 61 | 75 | 90.6 | 210 | 87.1 | 99 |
| 8A | 6 | 52 | 87 | 135 | 83.6 | | | |
| 7B | 2 | 35 | 115 | 152 | 87.0* | 268 | 82.7 | 99 |
| 7A | 6 | 38 | 72 | 116 | 78.4 | | | |
| 6B | 26 | 59 | 90 | 175 | 68.2 | 321 | 66.9 | 96 |
| 6A | 17 | 66 | 63 | 146 | 65.7 | | | |
| 5B | 46 | 101 | 72 | 219 | 59.9 | 382 | 55 2 | 94 |
| 5A | 28 | 92 | 43 | 163 | 54.6 | | | |
| 4B | 43 | 96 | 79 | 218 | 58.2* | 414 | 53.8 | 88 |
| 4A | 44 | 110 | 42 | 196 | 49.4 | | | |

*Step up, not down.

No deduction made for incorrect spelling.

Did not accept "deer," "wolf," "bear," "polar bear" or "whale,'" although these were commonly given by children. (Perhaps part credit should have been given for "deer" especially, and "wolf" meaning "dog.")

RESULTS WITH STEP W. (1595 PAPERS)

| Grade | *Number of Pupils Getting* 0 | 16⅔ % | 33⅓ % | 50 % | 66⅔ % | 83⅓ % | 100 % | Total No. of Pupils | Aver. % obtained | No. papers | Aver. % obtained | Percent. called for on scale |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8B | 0 | 0 | 0 | 1 | 5 | 23 | 46 | 75 | 92.0 | 210 | 93.2 | 98 |
| 8A | 0 | 0 | 0 | 8 | 14 | 53 | 70 | 135 | 94.4* | | | |
| 7B | 0 | 0 | 1 | 5 | 10 | 51 | 85 | 152 | 90.1 | 268 | 89.7 | 98 |
| 7A | 0 | 1 | 0 | 7 | 8 | 31 | 69 | 116 | 89.3 | | | |
| 6B | 0 | 2 | 3 | 10 | 26 | 47 | 87 | 175 | 85.6 | 321 | 83.8 | 94 |
| 6A | 0 | 3 | 3 | 17 | 8 | 62 | 53 | 146 | 82.1 | | | |
| 5B | 1 | 9 | 5 | 36 | 29 | 68 | 71 | 219 | 76.7 | 382 | 74.1 | 92 |
| 5A | 0 | 9 | 12 | 31 | 29 | 34 | 48 | 163 | 71.5 | | | |
| 4B | 0 | 10 | 5 | 69 | 72 | 43 | 19 | 218 | 64.5 | 414 | 54.1 | 84 |
| 4A | 12 | 30 | 42 | 50 | 61 | 0 | 1 | 196 | 43.7 | | | |

*Step up, not down.
No deduction made for incorrect spelling.

RESULTS WITH STEP S. (799 PAPERS)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8B, 8A | | | | | | | | | | 210 | 90.8 | 88 |
| 7B, 7A | | | | | | | | | | 268 | 89.7 | 88 |
| 6B, 6A | | | | | | | | | | 321 | 84.4 | 79 |

SCHOOL C (116 PAPERS)

| Grade | Scale step | *Number of Pupils Getting* 0 | 16⅓% | 33⅓% | 50% | 66⅔% | 83⅓% | 100% | Total No. of pupils | Average % obtained | Percent called for on scale |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | W | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 3 | 66.6 | 98 |
| 6 | W | 0 | 0 | 1 | 5 | 5 | 4 | 3 | 18 | 69.4 | 94 |
| 5 | W | 0 | 1 | 0 | 5 | 7 | 1 | 4 | 18 | 67.5 | 92 |
| 4 | W | 1 | 1 | 2 | 9 | 5 | 0 | 1 | 19 | 50.8 | 84 |
| 7 | X | 0 | | | 2 | | | 1 | 3 | 66.6 | 99 |
| 6 | X | 0 | | | 7 | | | 11 | 18 | 80.5 | 96 |
| 5 | X | 1 | | | 11 | | | 6 | 18 | 63.8 | 94 |
| 4 | X | 2 | | | 11 | | | 6 | 19 | 60.5 | 88 |

## Comments and Conclusions

As usual in this kind of work there were many strange answers. Some examples: Question—Name two animals used by the Eskimos. "Wales and popular bears;" "dogs and flanders;" "dogs and antler;" "iron and ore." Question—Name the capital of your state. "Hudson River;" "the government;" "Lincoln;" "President Wilson;" "San Francisco;" "United States;" "Alabama;". "the first letter of your name;" "meat." Question—Name two things that plants must have in order to live. "Dairying and manufacturing;" "potatoes and onions;" "coal and light;" "cabbages and potatoes;" "poison ivy and summer salt."

We cannot be too careful in recasting and polishing our questions so as to bring them within the range of every child who really has the knowledge to answer properly if the questions are clear.

The data in hand do not warrant any sweeping conclusions.

I believe, however, that the scale does offer a more accurate method of testing, and of measuring results, than the usual geography examination. At the same time our experience would seem to indicate the advisability of altering the phrasing of some of the questions along at least two lines: (a) to bring forth more specific answers, (b) to insure the children's grasping the meaning. As an example of "a" I would cite the scale question: "Name two ways in which the farmer helps to get food for us." As an example of "b" I would cite the scale question: "Name two things that plants must have to live."

The language difficulty has not been eliminated from this scale.

The results from the use of the scale disclosed marked deficiencies on the physical geography side. The Boston Geography Report brought out similar deficiencies in the children's knowledge. It would appear that possibly too much has been expected or attempted on this line with children.

The table for Step W, School B, shows a surprising regularity of increasing geographic content in the minds of the 1595 children tested. Even though they stood below the scale standard at all stages, nevertheless their progress was quite satisfactory.

On the whole, there is apparently a bit of truth in the statement that the scale is as much a test of general information as of geography. The fact that, as a rule, the results with eighth grade children were relatively nearer to the scale per cents. than were the results in lower grades gives support to this idea.

Specific weaknesses uncovered in the schools tested were a knowledge of the native state, and of certain features of Europe, notably the rivers. Teachers have in this connection spoken of the great practical value of the scale in showing them where to lay more emphasis in their work.

Further studies are being made and it is hoped that new light on the value of the scale will be obtained.

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# The Journal of Educational Psychology

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## EDITORIAL

**The Gary Survey**

Few school systems have received such wide advertising as that of Gary, Indiana. Few school surveys have aroused such widespread interest and such keen anticipation among all classes of educators in this country as the survey of that system undertaken by the General Education Board. And rarely indeed does a school survey afford such an opportunity as is now offered the many practical school men who have visited Gary to say "I told you so." What is it that we find? In the first place it is obvious that we have here the results of one of the most careful, painstaking and thorough surveys that has ever been made. The surveyors were recognized authorities in their fields and most of them had had extended experience in studying school systems. No expense was spared, and time enough was taken in the examination of the system for the surveyors to become thoroughly acquainted with the details of its workings. The most approved educational tests were used in the study of classroom products, and the greatest pains were taken to obtain objective and unbiased judgments.

And what are the final pronouncements of the survey on the efficiency of the organization as judged by the results attained? On the one hand the people of Gary are given great credit for adopting a broad conception of education and providing for a greatly enriched curriculum. The attempt has been made in the Froebel and Emerson schools to supply a physical equipment adequate to the demands of progressive educational ideals. This, of course costs money,—much more money than the traditional school building equipped with its stereotyped furnishings for a few abstract bookish subjects. Again it is found that the Gary plan of organization can accommodate a larger number of pupils than the same plant operated on the conventional plan. This is something of a truism. The real question is whether the Gary plan produces as good results in the attainments of the pupils as the conventional plan. Finally Gary has attempted to practice democratic theory in school conduct and discipline. This results in an atmosphere of freedom from restraint, an independence, a self-reliance sometimes bordering on self-assertiveness, that is not favored in the conventional school. What of its ultimate effect on the social and moral development of the pupils?

On the other side of the ledger the survey is perfectly frank in pointing out the weaknesses and defects of the Gary system,—and these are so serious as to give the thoughtful educator occasion to hesitate. Much has been made of the auditorium, the aesthetic and entertaining features of the Gary schools, and these have been undoubtedly well conducted. But there are some things in any school that have to be learned. One of the chief values of educational procedure is the demand it makes of the pupil to concentrate all his intellectual resources and *master* the difficulties that he encounters. Here is where the Gary atmosphere fails. The shops and the classrooms, as well as the auditorium and the playground, seem to be places for amusement and entertainment, the teachers work hard to supply diverting activities, and the pupils undertake what they feel like doing and enjoy themselves as much as they may. The administrative control of the Gary schools is so weak as to be almost non-existent. No school system can be trusted to run itself, much less a system embodying so many novelties as Gary professes. The educational supervision is defective. The standards of performance whether in the workshops or in the classrooms are distinctly low. Not that the principals and teachers do not want good work done, but the painstaking attention to details by which alone good work can be obtained is too irregular to be effective. Slipshod records are allowed to go unchallenged, self-criticism is lacking, and projects which seem to be ideal in theory fail for lack of careful scrutiny of results.

The study of the results produced by the Gary plan is therefore distinctly unfavorable. The scores obtained in the classroom tests showed the usual amount of variability from class to class, and while

some rooms made high records the average results fall short of legitimate expectations. The report is inclined to defend the theoretical aspects of the plan and to account for the poor showing in results on the basis of careless administration, lack of educational supervision, and a resulting lack of thoroughness and intensity of effort in the classroom work. But the world has long been familiar with the theory and has looked to Gary for the demonstration of its efficacy in practice. Now, under the most friendly examination, satisfactory results are lacking. May it not be that the very fundamental *laissez-faire* principle of the Gary idea is at fault? Are there not certain obligations resting upon teachers and pupils alike in their relations to each other and to school work that are essential to securing educational results? Is it not of the very essence of education to build up such habits of surmounting difficulties in arithmetic and history and geography and spelling that pupils will stand to their guns and in spite of distaste and discomfort will push through to the goal of attainment? Perhaps it is the very flabbiness of moral fibre inherent in the Gary theory that has caused the administration to be so weak, the supervision so inadequate, and the teaching so spineless. J. C. B.

# NOTES AND NEWS

The November meeting of the New York Society for the Experimental Study of Education had as its general theme the subject of "School Surveys." Principal Oswald Schlockow, of Public School 50, Brooklyn, reported on "A Study of the Pupis of Public School 50," which was undertaken at his request by the Division of Reference and Research shortly after he came to the school last spring. In the report stress was laid upon the results obtained from the use of the Woody Tests in Arithmetic, the Trabue Completion Tests, and the Briggs Cycle Test in English. Attention was called to the value of such surveys for teachers and principals, and the desirability of having a permanent organization of trained investigators in a city school system to carry on such surveys. Superintendent Don C. Bliss, of Montclair, New Jersey, gave an account of some testing that is being carried on in the Montclair schools, and Dr. Benjamin R. Simpson, of the Brooklyn Training School for Teachers, spoke on "Some Aspects of the Janesville, Wisconsin, Survey." At this meeting the Society organized by adopting a constitution and electing the following officers: President, William E. Grady, District Superintendent; vice-president, Stephen F. Bayne, Principal Public School 5, Manhattan; secretary-treasurer, J. Carleton Bell, Brooklyn Training School for Teachers; additional members of the executive committee, Arthur C. Perry, Jr., District Superintendent, and Truman Lee Kelley, Teachers College.

At the annual meeting of the American Psychological Association, held at Baltimore, December 27 and 28, the papers were limited to psychological work in connection with the war. At a joint session with Section H (Psychology and Anthropology), of the American Association for the Advancement of Science, a symposium was presented upon "The Future of Pure and Applied Psychology." Professor E. L. Thorndike, retiring vice-president of Section H, delivered an address on "Scientific Personnel Work in the United States Army," and Professor E. F. Buchner, retiring vice-president of Section L (Education), took as the topic of his address "Scientific Contributions of the Educational Survey."

The annual conference of the Education Association of Western Pennsylvania and of the Pittsburgh City Institute was held in Pittsburgh, November 29 and 30. The main topic was "The Results of Measurement," and one of the principal speakers was Mr. Stuart A. Courtis, director of the Bureau of Research, Detroit City Schools.

The first issue of the *Social Hygiene Monthly*, published by the War Department Commission on Training Camp Activities and the United States Public Health Service, has recently come to hand.

The journal is designed to assist the Government in its nation-wide crusade against venereal diseases. Copies may be procured by writing to 105 West 40th Street, New York, N. Y.

St. Louis is planning to establish a laboratory for the mental testing of children. Part of the money for the maintenance of the laboratory is to be furnished by the council of social agencies and part by the public schools. The plan is in every way like that governing the psychological laboratory in Cincinnati.

Edward Kidder Graham, president of the University of North Carolina, died of pneumonia at his home in Chapel Hill, N. C., on October 26. President Graham has stood for the democratic organization of university administration, and for the utmost possible service of the university to the people of the state. He was a pioneer in the work of university extension in the South, and through it became the guide and leader of all the forces within the state working for the fuller and freer life of the people.

President Charles R. Van Hise, of the University of Wisconsin, died on November 18. President Van Hise was one of the leaders of educational thought in the Middle West, and was a strong advocate of a national research university to be located at Washington.

Professor Morton Prince, founder and editor of the Journal of Abnormal Psychology, has been elected corresponding member of the Societe des Hopitaux de Paris.

Lieutenant George O. Ferguson, Jr., associate professor of psychology of Colgate University, is stationed at Camp Lee, Virginia, in care of the psychological examination of men at that camp.

Dr. William T. Sanger has been made dean and professor of psychology and education at the State Normal School, Harrisonburg, Virginia. He has served as director of the summer session for the last two years.

At the University of Washington Associate Professors Leonard V. Koos and Fred C. Ayer of the college of education were recently promoted to full professorships.

Dr. Allen J. Thomas, instructor in philosophy in Cornell University, has been appointed professor of philosophy, psychology and education in the Connecticut College for Women.

Dr. Wilford E. Talbert, director of the Bureau of Educational Investigation, San Francisco, has been appointed research assistant to Professor G. M. Whipple, who has charge of the Bureau of Salesmanship Research at the Carnegie Institute of Technology, Pittsburgh.

Among the books announced for early publications by Longmans, Green and Company are *Education and Social Movements, 1700–1850*, by A. E. Dobbs, and *An Introduction to General Physiology*, by William Maddock Bayliss.

# PUBLICATIONS RECEIVED

DON C. BLISS. *Methods and Standards for Local School Surveys.* New York: D. C. Heath and Company, 1918. Pp. xxiv, 264.

The school survey has been the focal point during the past eight years for the application of educational measurements. Whether this has been an unmixed blessing for the science of education may be open to question, but it has undoubtedly greatly stimulated the spread of the measurement ideal. The results of these surveys have not always been readily accessible, and the author of the present book has rendered a significant service in bringing together the most important findings of these investigations. As Professor Strayer says in his introduction, "Superintendent Bliss has given us in this book a manual which will be of very great help to the superintendent of schools who wishes to attack his problems in a scientific manner. He has brought together from his own practice and from the field of school surveys and investigations in educational administration the methods which can be most satisfactorily employed in checking up the work of a school system. He has dealt with the problems of attendance, classification and progress of children, with the financing of the school system, with the necessity for a building program, with the technique of measuring the achievements of pupils, and many other questions which are continually before the superintendent for solution. Throughout the book he has presented the case just as the superintendent of schools has to meet it from day to day. The method of attacking each of the problems has been described with such directness and simplicity as to make it available even for those who have had little special training in administration."

LEWIS CARROLL. *Alice's Adventures in Wonderland.* Edited by Clifton Johnson. Cincinnati: American Book Company, 1918. Pp. 154.

A richly illustrated edition of this children's classic designed for use as a supplementary reader in the schools. It should have a wide circulation.

CHARLES S. GARDNER. *Psychology and Preaching.* New York: The Macmillan Company, 1918. Pp. 389. $2.00.

"The field of educational psychology has been very thoroughly worked over, though the last word has by no means been said. The help which teachers have derived from it is very great, and no one now is considered equipped for that noble profession who has not mastered its principles. But so far as my knowledge extends. there have been few serious efforts to apply modern psychology to preaching . . . But there seems to be just as much reason for applying the principles of modern psychology to preaching as for applying them to teaching." Nor is it a mere collection of cursory reflections on the experiences of preaching that the author offers us. On the contrary it is a serious, thoughtful, scholarly work whose every page reveals the breadth of his reading and the soundness of his scientific foundations. Not only is the book a distinct contribution to the ever widening field of applied psychology, but the author's frank acceptance of the attitude of scientific inquiry even in matters of religious belief makes the work a valuable addition to the literature of religious sociology.

KENNETH SCOTT LATOURETTE. *The Development of Japan.* New York: The Macmillan Company, 1918. Pp. xi, 237. $1.50.

This admirable interpretation of the history and present conditions of the "Island Empire" will be welcomed with gratitude by all those who are interested in things eastern. The narrative is direct and compact, but clear and readable. The account of the external and internal development of the country in the past ten years affords a good foundation for appreciating Japan's present position in world politics.

E. MARKHAM LEE. *On Listening to Music.* New York: E. P. Dutton and Company, 1918. Pp. viii, 159. $1.50.

Many intelligent people who have a good native basis for musical appreciation fail to get much out of music because they do not know how to listen. The present work affords a sort of general introduction to musical analysis. After two general chapters on how music is constructed, the author takes up the chief forms of music, such as the orchestral compositions, the instrumental concerto, chamber music, pianoforte recital, the vocal recital, the oratorio, madrigals and part-songs, church music, organ recitals, the opera, and miscellaneous forms of concert, sketches the history and aim of each form and gives typical illustrations. For readers of some musical training the book should prove very interesting and useful.

JACQUES LOEB. *Forced Movements, Tropisms and Animal Conduct.* Philadelphia: J. B. Lippincott Company, 1918. Pp. 209. $2.50.

This is the first of a series of monographs on Experimental Biology, under the editorship of Jacques Loeb, T. H. Morgan and W. J. V. Osterhout, which includes in its list of contributors many of the foremost students of biology in this country. "It is the aim of this monograph to show that the subject of animal conduct can be treated by the quantitative methods of the physicist, and that these methods lead to the forced movement or tropism theory of animal conduct, which was proposed by the writer thirty years ago, but which has only recently been carried to some degree of completion." The writer here summarizes the results of his own experimental work and that of his pupils on reactions to an electric current, to light, to the pull of gravity, to currents of water and air, to solid bodies, to chemicals, and to changes in temperature. The final chapters deal with instincts and memory images. There is a bibliography of 554 numbers.

ERNEST CARROLL MOORE. *Fifty Years of American Education.* Boston: Ginn and Company, 1917. Pp. 96. Eighty cents.

This little books was prepared for the firm of Ginn and Company as a kind of memorial of their fiftieth anniversary. In 1867 Edwin Ginn took desk room in a Boston office and started the enterprise which has developed into a national institution. But there is nothing commercial in this book. So far as we have been able to discover the name of the firm is not even mentioned in the body of the text. It is a compact, well-balanced survey of educational progress in this country in the past half-century, with especial emphasis on contemporary features of educational endeavor. As a clear and lucid summary of a most significant educational period, the volume is to be commended.

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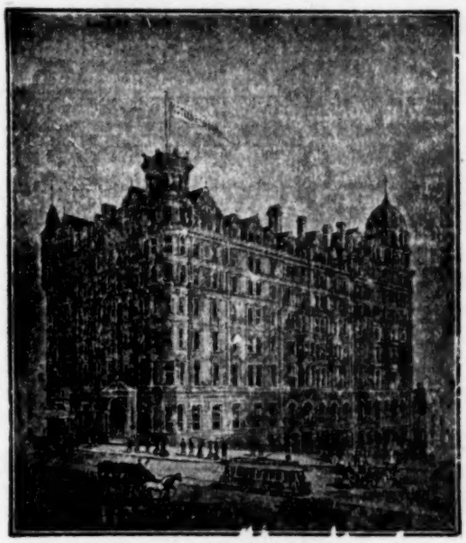

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# Directory of American Psychology Periodicals

**American Journal of Psychology**—Worcester, Mass.: Florence Chandler.
Subscription $5. 600 pages annually. Edited by G. Stanley Hall.
Quarterly. General and experimental psychology. Founded 1887.

**Pedagogical Seminary**—Worcester, Mass.: Florence Chandler.
Subscription $6. 575 pages annually. Edited by G. Stanley Hall.
Quarterly. Pedagogy and educational psychology. Founded 1891.

**Psychological Review**—Princeton, N. J.: Psychological Review Company.
Subscription (with Psychological Bulletin) $6. 480 pages annually.
Bi-monthly. General. Founded 1894. Edited by Howard C. Warren.

**Psychological Bulletin**—Princeton, N. J.: Psychological Review Company.
Subscription $3.25. 480 pages annually. Psychological literature.
Monthly. Founded 1904. Edited by Shepherd I. Franz.

**Psychological Monographs**—Princeton, N. J.: Psychological Review Co.
Subscription $4 per vol. 500 pp. Founded 1895. Ed. by James R. Angell.
Published without fixed dates, each issue one or more researches.

**Psychological Index**—Princeton, N. J.: Psychological Review Company.
Subscription $1.25. 200 pp. Founded 1895. Edited by Madison Bentley.
An annual bibliography of psychological literature.

**Journal of Philosophy, Psychology and Scientific Methods**—New York:
Sub-Station 84. Bi-weekly. 728 pages per volume. Founded 1904.
Subscription $3. Edited by F. J. E. Woolbridge and Wendell T. Bush.

**Archives of Psychology**—Substation 84, N. Y.: Archives of Psychology.
Subscription $5. 600 pp. ann. Founded 1906. Ed. by R. S. Woodworth.
Published without fixed dates, each number a single experimental study.

**Journal of Abnormal Psychology**—Boston: Richard G. Badger.
Subscription $5. 480 pages annually. Ed. by Morton Prince.
Bi-monthly. Entire field of abnormal psychology. Founded 1906.

**Psychological Clinic**—Philadelphia: Psychological Clinic Press.
Subscription $1.50. 280 pages annually. Edited by Lightner Witmer.
Monthly (9 numbers). Orthogenics, psychology, hygiene. Founded 1907.

**Training School Bulletin**—Vineland, N. J.: The Training School.
Subscription $1. 160 pp. Ed. by E. R. Johnstone. Founded 1904.
Monthly (10 numbers). Psychology and training of defectives.

**Journal of Religious Psychology**—Worcester, Mass.: Louis N. Wilson.
Subscription $3. 480 pages annually. Founded 1904.
Quarterly. Edited by G. Stanley Hall.

**Journal of Race Development**—Worcester, Mass.: Louis N. Wilson.
Subscription $2. 400 pages annually. Founded 1910.
Quarterly. Edited by George H. Blakeslee and G. Stanley Hall.

**Journal of Educational Psychology**—Baltimore: Warwick & York.
Subscription $3. 600 pages annually. Founded 1910.
Monthly (10 numbers). Managing Editor, J. Carleton Bell.

**Educational Psychology Monographs**—Baltimore, Md.: Warwick & York, Inc.
Published separately at varying prices.

**The Behavior Monographs**—Cambridge, Mass.: Emerson Hall.
Subscription $5. 450 pages per volume. Edited by John B. Watson.
Published without fixed dates, each number a single research.

**Journal of Animal Behavior**—Cambridge, Mass.: Emerson Hall.
Subscription $5. 450 pp. annually. Founded 1911.
Bi-monthly. Robert M. Yerkes, Managing Editor.

**Psychoanalytic Review**—Washington: 3617 Tenth Street, N. W.
Subscription $5. 500 pages annually. Psychoanalysis.
Quarterly. Founded 1913. Ed. by W. A. White and S. E. Jelliffe.

**Journal of Experimental Psychology**—Princeton, N. J.
Psychological Review Company. 480 pages annually. Experimental.
Subscription $3.25. Founded 1916. Bi-monthly. Edited by John B. Watson.

**Journal of Applied Psychology**—Worcester, Mass.: Florence Chandler.
Subscription $4. 400 pages annually. Quarterly. Founded 1917.
Edited by G. Stanley Hall, John Wallace Baird and L. R. Geissler.

# Forthcoming Articles

## The December number will contain the following articles:

JOHN P. HERRING, Seattle, Washington. *Measurements of Some Abilities in Scientific Thinking.*

Formal logic has fallen into disrepute, but the need for the study of logical processes is greater than ever. The author presents a series of tests in scientific reasoning, and discusses their use in individual and class diagnosis.

HARRY A. GREENE, State University of Iowa. *A Standardization of Certain Opposites Tests.*

The opposites test has been shown to have a high correlation with general intelligence and to be a good diagnostic instrument. Lists of opposites vary in difficulty, and in this study an attempt has been made to determine the relative difficulty of each term of the test. Each of the eighty stimulus words is given a point rating on the basis of nearly one thousand responses.

W. W. THEISEN AND CECILE WHITE FLEMMING, Bureau of Educational Measurements, State Department of Public Instruction, Madison, Wisconsin. *The Diagnostic Value of the Woody Arithmetic Scales: A Reply. Part II.*

The authors point out some of the possibilities of the tests as diagnostic instruments. Striking weaknesses of arithmetical ability or arithmetical deficiency are clearly brought out, and the important factors entering into the score are readily identified. Remedial work is easily prescribed, and the teacher by the use of this scale can minister more intelligently to the needs of the individual pupil.

## The January number will contain the following articles:

ARTHUR W. KALLOM, Department of Educational Investigation and Measurement, Boston. *The Importance of Diagnosis in Educational Measurement.*

Educational measurements should ultimately bring about an improvement in the education of each boy and girl. To do this emphasis must be laid upon the value of measurements to the teacher in detecting the particular weaknesses of individual pupils, and in helping her to devise corrective measures. Examples are given from the use of the Courtis Arithmetic Tests.

W. L. UHL, Northwestern University. *Mentality Tests for College Freshmen.*

The author tested a group of two hundred freshmen with the Trabue Completion tests, hard opposites, and a range of information test. The opposites and the completion tests were found to be more satisfactory than the range of information test. All correlations, however, were low.

LEWIS M. TERMAN, Leland Stanford University. *Some Data on the Binet Test of Memory Words.*

In half the cases this test alone yields a mental age within one year of that secured by the entire Stanford-Binet scale. The drop in number of words from the first minute to the second is about the same as from the second to the third.

HANOR A. WEBB, George Peabody College for Teachers. *A Preliminary Test in Chemistry.*

After elements, mixtures and compounds were studied at the beginning of the course in elementary chemistry, a list of fifty terms was given the pupils for classification. The number of correct responses to each term is indicated.

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